THE

TWENTY-THIRD ANNUAL REPORT

OF THE

MARYLAND

Agricultural Experiment Station,

COLLEGE PARK

PRINCE GEORGE CO., MARYLAND.

1909–1910.

PUBLISHED BY THE STATION.

6262320

The Maryland Agricultural Experiment Station.

CORPORATION.

STATION OFFICERS AND STAFF.

Harry J. Patterson, B. S................ *Director and Chemist.*
Samuel S. Buckley, M. S., D. V. S....... *Animal Pathologist.*
J. B. S. Norton, M. S...................*Botanist and Pathologist.*
*Thos. B. Symons, M. S................. *Entomologist.*
C. P. Close, M. S........................ *Horticulturist.*
N. Schmitz, M. S........................*Agronomist.*
E. H. Brinkley........................ *Farm Superintendent.*
Thos. H. White........................ *Gardener.*
Geo. Edward Gage, Ph. D...............*Biologist.*
Chas. O. Appleman, Ph. D..............*Physiologist.*
A. B. Gahan, M. S.................... *Associate Entomologist.*
C. L. Opperman.........................*Associate Poultryman.*
W. R. Ballard, B. S....................*Assistant Horticulturist.*
*Alvah J. Norman, M. S.................*Assistant Botanist.*
L. B. Broughton, B. S................. *Assistant Chemist.*
Austin L. Stabler, B. S.................*Assistant Animal Husbandman*
*E. N. Cory, B. S.......................*Assistant Entomologist.*
Thos. R. Stanton, B. S................. *Assistant Agronomist.*
O. G. Babcock, B. S.................... *Assistant Entomologist.*
R. S. Allen...........................*Assistant Dairyman.*
L. B. Kimble..........................*Stenographer.*
E. J. Gardner.........................*Clerk.*
H. Ford...............................*Treasurer.*

*On State Horticultural Department Work.

The Station is located on the B. & O. R. R. and City and Suburban Electric Car Line, eight miles north of Washington, D. C.
Bell Telephone—Hyattsville 55-R.

Visitors will be welcomed at all times, and will be given every opportunity to inspect the work of the Station in all of its departments.

The Bulletins and Reports of the Station will be mailed regularly, free of charge, to all residents of the State who request it.

ADDRESS:

AGRICULTURAL EXPERIMENT STATION,
College Park, Md.

LETTER OF TRANSMITTAL.

To His Excellency, Austin L. Crothers,

Governor, and President of the Board of Trustees,

Annapolis, Maryland.

Sir:—In accordance with the provisions of Section No. 3 of the Act of Congress, approved March 2, 1887, "To Establish Agricultural Experiment Stations," etc., I have the honor to transmit the Twenty third Annual Report of the Maryland Experiment Station for the fiscal year ending June 30, 1910.

Very respectfully yours,

H. J. PATTERSON,

July, 1910. Director of the Experiment Station.

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THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

Volume 23. 1909-1910.

Twenty-third Annual Report of the Maryland Agricultural Experiment Station.

FOR THE YEAR ENDING JUNE 30, 1910.

BY H. J. PATTERSON, Director.

To the Board of Trustees of the
Maryland Agricultural Experiment Station.

GENTLEMEN:—In accordance with the usual custom, I hand you herewith a report upon the work and expenditures of the Experiment Station for the past fiscal year, with outlines and recommendations for the coming year.

GENERAL STATEMENT.

The interest in agriculture in Maryland is growing rapidly with the increased number of people pursuing this industry and the increased profits being derived therefrom. This condition causes a considerable demand upon the time of all Station employees through personal interviews, correspondence and calls for addresses at various farmers' meetings. Time consumed in this way gives little to show of a tangible nature, and necessarily reduces the amount of investigational work which can be followed and completed.

STATION ORGANIZATION AND SCOPE OF WORK.

The following outline will give briefly a general idea of the lines of work being pursued by the different members of the Station staff:

SOILS.	Fertility Investigations. Manure, Green Manures. Lime, Fertilizers, Tillage.	H. J. Patterson. L. B. Broughton. N. Schmitz. E. H. Brinkley.
CROPS.	Horticultural Crops.	C. P. Close. W. R. Ballard. Thos. H. White.
	Cereals, Forage and Green Manure Crops.	N. Schmitz. T. R. Stanton.
	Tobacco (In cooperation with U. S. Dept. of Agr.)	E. H. Matthewson. D. E. Brown.
	Botany, Diseases, Physiology and Pathology.	J. B. S. Norton. C. O. Appleman. A. J. Norman.
	Entomology.	T. B. Symons. A. B. Gahan. L. M. Peairs. E. N. Cory.
ANIMALS.	Dairy.	S. S. Buckley. H. J. Patterson.
	Poultry.	C. L. Opperman. G. E. Gage.
	Swine.	A. L. Stabler.

SOILS AND FERTILITY INVESTIGATIONS.

There is no class of investigations so important or which are of so much interest to farmers as those which relate to the fertility of the soil. New points are constantly arising which call for new investigations, and the results of old investigations must be adapted to new conditions. The amount of work needed on these problems seems endless, and it is to be regretted that we cannot cover a wider field and get results more quickly.

The investigations in progress at present are as follows:

1. Tests of different forms and sources of phosphoric acid.
2. Test of nitrogen fertilizers.
3. Comparison of carbonate and caustic lime.
4. Comparison of carbonate of lime from stone and oyster shells.
5. A study of the rate of diffusion and depletion of lime in different kind of soils.
6. The use of green manures for renovating soils.
7. The use of deep plowing as a source of fertility.
8. A study of the use of farm manures.

CEREALS, FORAGE AND GREEN MANURE CROPS INVESTIGATIONS.

Two-thirds of the value of the products of Maryland farms is derived from the cereals and forage crops.

The investigations with these crops consists chiefly of studies of varieties and strains and the improvement of seed through selection and breeding.

The following is a brief outline of the work now in progress and the new lines of investigations to be taken up by this department this season:

Corn.

1. Breeding plots of Leaming and Munnikhuysen corn.
2. Testing of the degree of inbreeding or close breeding, which may be safely practiced.
3. Variety tests at the Experiment Station, including twenty-one varieties.
4. Cooperative variety tests with farmers in different parts of the State.
5. Rate of planting test, with three varieties.
6. Testing the influence of crossing different strains of the same variety and different varieties, upon the yield of grain.

Small Grains.

1. Wheat: (a) Breeding plots of Currell and Fultz. (b) 101 variety and selection plots.
2. Fall Oats: Thirteen variety plots.
3. Barley: eight variety plots.
4. Spelt: six variety plots.
5. Emmer: (a) three variety plots.

Alfalfa.

1. Breding for seed producing strains.
2. Fertilizer tests.
3. Cutting experiments.
4. Date of seeding experiments.
5. Experiments to determine the cause of alfalfa fields dying out suddenly.

Clovers—Red, Mammoth, Alsike and White.

1. Breeding for disease resistance.

Cowpeas.

1. Breeding plots of three varieties.
2. A variety test.
3. A study of the methods of harvesting and threshing cowpea seed.
4. A test of corn when grown with and without cowpeas.

Sweet Corn.

Breeding two varieties of sweet corn, Country Gentleman and Stowell's Evergreen:

1. For a higher percentage of sugar.
2. For a higher yield.
3. For uniform white color of cob and silk.
4. A study of relation of physical character and sugar content.

Hairy Vetch.

An experiment to determine if Hairy Vetch seed can be grown profitably.

Green Manure Experiments.

1. Testing the value of different legumes and non-legumes when used as a green manure crop.

2. Testing different methods of handling cowpeas when followed by wheat and corn.

3. Testing different methods of handling crimson clover when followed by corn.

4. Testing the value of lime when used in connection with green manure crops.

TOBACCO INVESTIGATIONS.

These investigations are being conducted in cooperation with the U. S. Department of Agriculture. They have detailed one of their experts, Mr. E. H. Mathewson, to supervise the tobacco investigations in Maryland and Virginia. They also have placed a trained man, Mr. D. E. Brown, in the field to devote all of his time to the Maryland work. This Experiment Station furnishes the funds for the miscellaneous expenses, such as labor, fertilizers, etc. The tobacco work is being conducted at Upper Marlboro, in Prince George County, and at Chaney in Calvert County, as typical conditions and soils could be procured at these points. The land used for these tests is rented from year to year with the understanding that the contract can be renewed if desired. The investigations being conducted with this crop may be grouped under the following heads:

1. Tests of varieties.

2. The improvement of the crop by seed breeding and selection.

3. Fertilizer tests on tobacco.

4. Residual effects of fertilizers applied for tobacco on the yield and value of other crops in the rotation.

5. Tests of other money crops as a substitute for tobacco in this rotation.

These investigations have already given very interesting results, and indicate that the rotation and system followed will not only influence better methods with tobacco, but will ultimately make Southern Maryland a great hay-producing section, and thus make them exporters instead of importers of this crop.

HORTICULTURAL INVESTIGATIONS.

The horticultural interests and the interest in horticultural crops is growing yearly in amount, kind and extent in Maryland. This condition causes a great demand upon the time of the men in this department for help of a miscellaneous character, which, together with the time given to the work of the State Horticultural Society, keeping records, making photographs, growing vegetables for college domestic department and teaching, take time which could otherwise be devoted to the investigations.

Many of the lines of work are conducted jointly by the workers in this department, but as far as practicable the work is divided, and each one has entire charge of certain investigations, as follows:

C. P. Close:
- Nut-tree investigations.
- Peanut investigations.
- Mushroom culture.
- Orchard heating.
- Apple breeding.
- Fertilizers and cover crops in apple orchards.
- Sweet cherry investigations.
- Fertilizer effects on plant structure.

W. R. Ballard:
- Geranium breeding.
- Pear breeding.
- Peach investigations.
- Strawberry testing.
- Raspberry culture.
- Tomato culture.
- Muskmelon testing.
- Preserving fluids for fruits.
- Apple and pear propagation by cuttings.
- Feeding plants with copper solutions for disease resistance.
- Reciprocal influence of scion and stock.

T. H. White:
- Asparagus experiments.
- Cabbage experiments.
- Celery experiments.
- Irish potato investigations.
- Onion experiments.
- Sweet potato culture.
- Variation of plants by excess of plant food in various forms.
- Gooseberry and currant fertilizer tests.
- Carnations, chrysanthemums, roses, sweet peas and violets.

New Equipment.

During the year two new greenhouses, 20 x 50 feet, and a cement block mushroom house, 8 x 43 feet, all inside measurements, have been constructed. The new greenhouses run east and west, and one of them will be devoted to rose culture for several years in comparison with the north and south rose house built two years ago. The other new greenhouse is known as the Adams house, and is used for research work in horticulture under the Adams fund. The mushroom house will be used to work out problems in mushroom culture with the hope of stimulating this industry in Maryland, especially in the sections where natural caves abound. The adaptability of caves for this purpose will depend largely upon temperature control.

INVESTIGATIONS IN BOTANY, PHYSIOLOGY, PATHOLOGY AND DISEASES OF PLANTS.

Prof. Norton is the leader in the projects being carried on in these subjects. He devotes five-sixths of his time to work outlined under the provisions of the U. S. Adams act, and one-sixth to the work of the State Horticultural Department. In college and State work he has had the assistance of Messrs. Norman and Walls. Next year Mr. Appleman will be associated on the Adams fund work and will supplement the investigations with chemical and physiological studies.

Plant Disease Investigations.

The investigations in progress may be classified as follows:

1. Determining the distribution of plant diseases.
2. Determining methods of controlling plant diseases.
3. Effects of treatment for the control of potato scab on germination.
4. Demonstration work with Bordeaux in orchards.
5. Demonstration work with concentrated lime-sulphur as a summer fungicide.
6. Tests of Bordeaux on potatoes and tomatoes.
7. A study of the diseases of roses in the greenhouse.
8. Effect of diseased seed or seed of diseased plants on the product.

Botanical Investigations.

1. A study of the distribution of weeds and grasses.
2. A determination of the variation within the species of some wild plants, and whether the variations are hereditary.
3. Determining the purity and vitality of seed.

Physiological Investigations.

1. The effect of external and internal applications of chemicals on the physiology and structure of plants.
2. The relation of chemicals to mutations in plants.
3. The determining of what and how chemicals kill weeds.
4. The effect of weather conditions on weed killing.
5. Studies of the treatment of the pollen with chemicals for the production of mutations.
6. Devising methods for conducting above tests so as to cause the least disturbance of normal activities.

Pathological and Chemical Studies.

1. On peach yellows.
2. On the cause of water core in apples.

The investigations on these subjects may have the following bearing on commercial interests.

1. More simple and economical methods of making Bordeaux mixture.
2. Publications and demonstrations on the use of fungicides which, if used as recommended, would increase the income from many crops from 10 to 25 per cent.
3. The saving of time and money by farmers from the knowledge of whether weeds or diseases sent in were dangerous or not.
4. Assistance in selecting proper seed.
5. Saving from use of valueless patent compounds tested.
6. Development of a perfectly safe fungicide for fruits.
7. Spraying to make possible the use of Western Maryland potato seed in place of northern grown.
8. Possibility of finding new methods of yellows control.
9. Utilization of wild plants.
10. Development of possibility of applying fertilizers in form of spray for more thorough distribution and killing weeds and weed seeds.
11. Practicability of economically killing certain weeds by sprays of poisons, etc.
12. Keeping weeds under control by stimulating the crop.
13. Bringing to light principles of use to plant breeders.
14. Collecting material for instructions on control of greenhouse diseases on which there is now no general work published.
15. Discovery that 5 per cent. Formalin used for disinfecting seed tester retards germination.
16. That when some sprays are soon washed off weeds they recover, while with strict poisons this is not the case.

17. That plasmolysing sprays act best in dry and warm weather.

18. The vapor from phenol impregnated fertilizer may be injurious to plants, and a simlar one containing naphtaline was not injurious.

19. Many of the strictly scientific investigations are of indirect commercial value and difficult to estimate or may reveal principles that may be applied in future control of diseases, crop stimulation, securing new variations, etc.

Entomology.

There is scarcely an agricultural or horticultural crop that is not attacked or injured to some extent by one or more insects. This condition causes an ever-increasing demand for help in their control and necessitates many investigations in order to intelligently and economically handle the problems.

In the control of insects, as with every other branch of agriculture, knowledge as to how it should be done has accumulated faster than the majority of farmers have put it in practice. Consequently, a considerable amount of demonstration work is being done, and the results obtained would seem to indicate the wisdom of such a policy and warrant its extension.

The Experiment Station and the State Horticultural Department have cooperated in conducting many of the investigations.

The following is a brief outline of the experiments being pursued at present:

1. Test of spray mixtures for the control of San Jose scale.
2. Comparing fall and spring spraying for San Jose scale.
3. Test of dipping nursery trees and seedlings in different insecticides for the control of insect pests.
4. Determination of the agencies and means by which San Jose scale is distributed.
5. Experiments on methods for the control of the Peach Lecanium.
6. Studies of the life history and habits of the codling moth and demonstrating means for its control.
7. Studies of the life history and methods for controlling the peach tree borer.
8. Experiments on destroying Woolly aphis and Green aphis.
9. A study of the life history, habits and means for controlling the corn ear worm.
10. A study of the life history, habits and means for controlling Plum curculio.
11. A study of the relation of the house-fly to disease and means for its suppression.
12. Investigations of the hymenopterous parasites (conducted under the provisions of the Adams Fund).

The greater part of the time of the men in the entomological department is devoted to the orchard and nursery inspection necessitated under the provisions of the State Horticultural law. This part of the work was unusually heavy the past season on account of the inspection of nearly three and-one-half million imported nursery plants to prevent the introduction of the Brown Tail Moth.

In this work over 700 nests of this moth were discovered and destroyed, and thus prevented from distribution. This work alone has saved the State many times the total cost of this department since its establishment.

Animal Husbandry.

The work of the Experiment Station with animals has not been as extensive as the importance of the industries would warrant, owing to lack of means and facilities. There is no question but that many kinds of live stock husbandry can be profitably pursued in the State. As a rule those farms and sections where live stock has been given an important place are the most fertile and best off financially.

The live stock investigations at present are confined to studies with the dairy, poultry and swine. These are the most important live stock interests, and they encounter more difficulties, hence need more help.

The sheep industry offers great opportunities for profit, and should be greatly stimulated. It is estimated that there is sufficient hill land in Western Maryland, that at present is unprofitable, to carry at least a million sheep which could be made to net five dollars per head per year.

Dairy Investigations.

The dairy investigations consist in general of studies which will benefit both the producer and consumers of milk. The heaviest part of the work which has been done recently has been along lines which would throw some light on what constituted the food qualities of milk, and how to determine abnormal milks.

These are important questions, both to producers and consumers, from the fact of the tendency to formulate many arbitrary laws governing the sale of milk which are not backed by scientific facts.

For instance, the usual custom is to base the food value of milk wholly on its fat content, and the tendency is towards raising the requirements for that constituent. Yet it is very questionable whether milk very high in fat is usually as good for the people that consume the bulk of it as low, or moderately high fat milk should be.

The following is a list of the investigations now in progress:

1. The effect of Leucocytes in milk. This study combines microscopical and chemical work, and is far enough advanced to warrant the publication of the results.

2. The effect of the size and quantity of the fat cells on the food value of milk. This work will include a study of all the variations which may occur in the fat of milk, both from individual cows and of different breeds.

3. The effect of the system of housing of cows on milk production and health.

4. A study of tuberculosis in cows. A report on this subject is now completed and in press.

5. A study of the relation of services to abortion.

6. A study of milk substitutes in calf feeding.

7. Studies of means for cheapening the cost of production of dairy products.

8. Cooperation with farmers in testing cows.

There is no doubt but that about one-third of the cows in the State are unprofitable, and helping to consume the profits of the other two-thirds. Many farmers are beginning to realize this fact, and are asking for assistance in correcting this condition.

For the purpose of giving this help we are assisting in the formation of cow testing associations.

Poultry Investigations.

The investigations in connection with Poultry may be divided in a general way into two classes: Commercial poultry problems which are being carried on with Hatch and State funds, and studies on poultry diseases which is being pursued under the provisions of the Adams funds.

The Adams fund investigations, which are being conducted by Dr. George Edw. Gage, has consisted the past year, of fundamental studies.

1. A study of the bacteria and animal organisms in the intestinal contents and mucosa of healthy chickens. These studies have been made on chickens ranging in age from those just hatched up to fowls two years old.

2. The effect of complete caecunectomy upon the metabolism of the domestic fowl. This study was taken up to determine the part which the caeca performs and its relation to disease.

In carrying out these studies to the best advantage more space is needed for laboratory, operating and hospital purposes, and some of these operations should be conducted in separate rooms. In order to provide for this need I would recommend that an addition be made to the present building.

The commercial problems under investigation have been outlined in previous reports.

The work on the housing of poultry has gone far enough to warrant a preliminary report, and this has been prepared and is now ready for press.

The house test will be reduced the coming winter to include only the two extreme conditions, and the intermediate houses will be used for feeding experiments. The feeding experiments outlined will consist of studies in simplifying poultry rations with particular reference to adapting them to feeds grown on the farm. Two breeds will be used in this work—White Leghorns and Rhode Island Reds—so as to eliminate differences which may occur with the light and heavy classes.

It is also proposed to establish two pens of breeding fowls kept under commercial conditions. This is to serve the double purpose of illustration and supplying stock for future investigations which have not been subject to abnormal conditions.

During the summer it is planned to prepare an exhibit for use at some of the principal poultry shows, giving the idea of the work in progress and the results obtained.

Swine Investigations.

Hogs are the most important source of meat supply in the State, and with the increasing price of feeds it is important to study every phase of the question of production. Considerable time has been spent the past year in preparing for publication the results of the feeding tests conducted during the past three or four years.

The investigations in progress at present are as follows:

1. Determining the cost of raising pigs to the weaning age.

2. Camparison of dry feed in hoppers with same feed as slop.

3. Comparison of home-made wooden hopper feeding with "The Hog Motor" hopper feeding.

4. A comparison of soft coal, wood charcoal and tonic mixture as a supplementary feed or corrective.

5. The determination of a balanced ration as indicated by the hogs' appetites.

It is hoped that some investigations on the hog industry systems of hog managemnt and manner of preparing hog products for market and the curing of meat as followed in Maryland can soon be made. There is no doubt but that some of Maryland's pork products are the best that can be produced, but for the sake of the general standard the knowledge of the best producers should be placed at the disposal of all the people.

Hog cholera seems to be the most serious disease with which this industry has to contend. This trouble not only reduces the profits materially, but keeps many persons from engaging in the industry.

The effectiveness of the serum treatment for immunizing against cholera should be tested very thoroughly, and if found to possess sufficient merit some plan should be formulated to enable the State Live Stock Sanitary Board to have a supply at its disposal.

I would suggest that this institution do all it can to cooperate in furthering such a plan.

STATION STAFF.

During the year a number of changes have taken place in the Station staff owing to resignations.

A. P. Davidson and R. E. Karper, of the clerical force, resigned in order to go to college, and their places were filled by the appointment of L. B. Kimble and R. T. Brandenburg, both of Washington County.

C. W. Nash, assistant agronomist, resigned September 1st, to accept a similar position at the Kansas Agriculture College. This vacancy has been filled by the appointment of T. R. Stanton, a graduate of this year's class of the Maryland Agriculture College. Mr. Stanton has assisted in the work during vacation periods for two years, and is already quite familiar with the details. The position authorized some time ago in plant chemistry and physiology has been filled by the appointment of Mr. Chas. O. Appleman, a Ph. D. of Chicago University. Mr. Appleman was reared on a farm in Pennsylvania, and has been in practical touch with farm conditions, has done farmers' institute work in Illinois and is working along investigational lines closely allied to the work we have in hand. I found very few men equipped for this kind of research work. Mr. Appleman will be employed under the provisions of the Adams fund.

Mr. C. L. Opperman resigned the position of Associate Poultryman June 30, 1910, to accept a position in the U. S. Dept. of Agriculture. This vacancy was filled by the appointment of Mr. Roy H. Waite, B. S., of Michigan Agricultural College. Mr. Waite has assisted in the Poultry Department of the Michigan and the Rhode Island Stations, and has had much practical experience in the work.

EXHIBITS.

The Station made exhibits last year at a number of fairs. This exhibit represented the work of the Agronomy department. I would recommend that the following exhibits be made at the places indicated the coming season.

A Horticultural exhibit at Pocomoke City Fair, Wicomico County Fair, Talbot County Fair, Tolchester Fair, Baltimore County Fair, Frederick County Fair, Hagerstown Fair and State Horticultural exhibit.

An Agronomy exhibit at Southern Maryland Fair, Montgomery County Fair, Hagerstown Fair, Cereal and Forage Crop Breeders' exhibit and the National Corn Show at Columbus, Ohio.

A Poultry exhibit at Taneytown exhibit and picnic, Hagerstown Fair and State Poultry Show.

The expenses of transportation, installation and attendance necessary in making the exhibit at the National Corn Show will be paid by the National Association.

PUBLICATIONS.

During the year we have issued the following publications:

July, 1909—The Twenty-second Annual Report.

July, 1909—Bulletin 137, The Angoumois Grain-Moth, by Thomas B. Symons.

August, 1909—Bulletin 138, The Poultry Industry of Maryland, by C. L. Opperman.

October, 1909—Bulletin 139, A Tape-worm Disease of Fowls, by G. E. Gage and C. L. Opperman.

November, 1909—Bulletin 140, The San Jose Scale and the Osage Orange Hedge, by T. B. Symons and L. M. Peairs.

January, 1910—Bulletin 141, Corn Varieties, Seed Selection, Testing and Breeding, by C. W. Nash.

February, 1910—Bulletin 142, The Codling Moth, by T. B. Symons.

February, 1910—Bulletin 143, Plant Diseases and Spray Calendar, by J. B. S. Norton and A. J. Norman.

February, 1910—Bulletin 144, Apple Culture, by C. P. Close.

June, 1910—Bulletin 145, Tuberculosis of Animals, by S. S. Buckley.

Some other bulletins are ready for press as mentioned previously in this report. There has been such a great demand for our bulletins on Liming Soils, The Use of Stable Manure and The Poultry Industry of Maryland that the first edition has been entirely exhausted, and the demand for information on these subjects continues to come in great numbers from our own people.

Consequently, as the amount appropriated for printing would permit second editions of 2,000 each of these bulletins have been ordered.

General Farm Operations.

The general farm operations are in better shape than ever before. Much clearing and draining of land has been done the past year. This has made land available for cultivation and pasture, which was previously unproductive, and better fitted much of it for experimental purposes.

All of the land is fenced, which has given a much-needed protection to the place and the work in progress. Most all of the general farm operations are made to contribute either directily or indirectly to the

investigations in progress, and at the same time they are conducted on as practical and economical a basis as possible.

FINANCES.

The work the past year has been conducted within the Station's income, and in accordance with the lines of work adopted and the appropriations made for this fiscal year. Some of the accounts will show small balances, as the heaviest expenses in connection with some of the investigations will come a little later in the season. The following report of the Treasurer shows the revenues and expenditures for the past year:

HATCH FUND.

MARYLAND AGRICULTURAL EXPERIMENT STATION, IN ACCOUNT WITH THE UNITED STATES APPROPRIATION.

DR.

To receipts from the Treasurer of the U. S., as per appropriations for the fiscal year ending June 30th, 1910, as per Act of Congress, March 2nd, 1887	$15,000 00
To interest, on deposit	50.50
	$15,050 50

CR.

Salaries	$10,947 28	
Labor	1,177 55	
Publications	773 05	
Postage and Stationery	183 14	
Freight and Express	264 68	
Heat, Light, Water and Power	137 76	
Chemical Supplies	27 84	
Seed, Plant and Sundry Supplies	91 98	
Library	120 85	
Tools, Imp. and Machinery	106 81	
Furniture and Fixtures	28 25	
Live Stock	650 00	
Feed Stuffs	524 61	
Contingent Expenses	16,70	
		$15,050 50

The above is a true copy from the books of this office.

HERSCHEL FORD,

Treasurer Maryland Agricultural Experiment Station.

ADAMS FUND.

DR.

United States Appropriation	$13,000 00

CR.

1910.		
By Salaries	$9,026 29	
Labor	3 87	
Postage and Stationery	54 05	
Heat, Light and Water	243 88	
Chemical Supplies	329 73	
Seeds, Plants and Sundry Supplies	66 36	
Fertilizers		
Feed Stuffs	1,829 65	
Library	345 18	
Tools, Imp. and Machinery	93 20	
Scientific Apparatus	196 60	
Furniture and Fixtures	47 80	
Live Stock		
Traveling Expenses	122 10	
Buildings and Repairs	641 29	
		$13,000 00

The above is a true copy from the books of this office.

HERSCHEL FORD,

Treasurer Maryland Agricultural Experiment Station.

STATE FUND.

1909.		
July 1st—To Cash Balance		$22 46
Appropriation from State		7,500 00
To Interest		5 11
		$7,527 57

CR.

By Repairs	1,467 73	
Publications	1,499 01	
Exhibits	190 76	
Freight and Express	564 48	
Feeding Experiments	33 60	
Tobacco Experiments	1,360 07	
Poultry Experiments	109 00	
Insurance	19 50	
Labor	93 14	
Seed, Plants, Sundry Supplies	391 52	
Tools, Imp. and Machinery	113 20	
Light, Heat and Water	48 21	
Traveling Expenses	78 82	
Salaries	1,342 12	
Postage and Stationery	91 21	
Irrigation and Drainage	47 49	
Fertilizer	64 50	
Library	3 40	
		$7,517 76
Balance		9 81
		$7,527 57

The above is a true copy from the Books of this office.

HERSCHEL FORD,

Treasurer Maryland Agricultural Experiment Station.

1910.

HORTICULTURAL FUND.

DR.

July 1st—To Cash Balance	$8 29	
Interest	20 71	
State Appropriation	4,000 00	
		$4,029 00

CR.

1909.		
Salaries		
Seeds, Plants and Sundry Supplies	$937 40	
Travel	180 48	
Library	73 38	
Labor	902 05	
Fertilizer	109 36	
Postage and Stationery	50 75	
Tools, Imp. and Machinery	98 06	
Heat, Light and Water	181 96	
Publications	454 52	
Freight and Express	393 45	
Buildings and Repairs	280 50	
Furniture and Fixtures	313 42	
Scientific Apparatus	26 45	
		$4,029 00
	$4,001 78	
Balance	27 22	

The above is a true copy from the books of this office.

HERSCHEL FORD,

Treasurer Maryland Agricultural Experiment Station

STATION FARM FUND.

DR.

1909.		
July 1st—To Cash Balance		$57 22
Sale of Stock and Produce		8,189 46
Interest		3 12
		$8,249 80

CR.

Live Stock	$330 00	
Fertilizer	161 45	
Feed Stuffs	131 93	
Travel	157 19	
Freight and Express	49 31	
Seed, Plants and Sundry Supplies	214 68	
Tools, Imp. and Machinery	20 33	
Labor	6,504 64	
Exhibits	47 38	
Light, Heat and Water	8 00	
Insurance	36 95	
Buildings and Repairs	128 42	
General Supplies of Fur. and Fixtures	29 30	
Postage and Stationery	37 28	
Balance	392 94	
		$8,249 80

The above is a true copy from the books of this office.

HERSCHEL FORD,

Treasurer Maryland Agricultural Experiment Station.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 137. JULY, 1909.

THE ANGOUMOIS GRAIN-MOTH.

By Thomas B. Symons.

INTRODUCTION.

The corn and wheat crops of Maryland at present constitute the greatest money crops of the State. Upon the returns from the sale of these cereals the great majority of our farmers depend for pecuniary profit in their business. Further, these cereals are of fundamental importance as food to man and beast. Therefore any injury done to either of these crops by an insect pest is of greater magnitude than a similar per cent of injury to crops that are not cultivated on such a large scale or that are not of such commercial importance. A small per cent of injury to these crops means loss to a greater number of people and correspondingly causes a greater loss in the aggregate to the State than a much greater per cent of injury to crops that are not so generally grown and on which not so much importance is placed by our people.

It is a common occurrence to receive complaints of injury to stored corn or wheat by what is generally designated as the "fly weevil" but what is properly called the Angoumois grain-moth (Sitotroga cerealella, Oliv). What may be called a notable outbreak of this insect occurred in the northern and central parts of the State the past year. In reality, it was probably not a spasmodic outbreak of the insect, but instead a gradual increase of the pest from year to year has taken place until their numbers in 1908 reached such proportions as to ruin thousands of bushels of wheat in that part of the State. The practice of growers in many regions of the State is to store the wheat unthreshed in their barns, preferring to store in this manner until winter when it is threshed at their convenience. This treatment of the crop has afforded abundant opportunity for the continued increase in numbers of the moths and a corresponding injury to the grain.

The market value of these grains during the past year and the prospective value of the present crop emphasizes the importance of preventing any needless loss through this insect. Moreover, the shortage of the wheat crop this season due to natural causes emphasizes the need of proper care of that which is harvested.

The present bulletin is therefore prepared with a view to calling the attention of the farmers, millers, and tradesmen of the State to the serious injury that this insect is capable of causing, the importance of preventive measures and suggesting the best means of holding it in check.

OCCURRENCE AND DISTRIBUTION.

The Angoumois grain-moth is supposed to have originated in Southern Europe. The insect received its common name from the province of Angoumois, France, where it is said to have been a serious pest from earliest times. It is said to have been recognized in this country as early as 1728 when it appeared in North Carolina and Virginia. It was reported from Maryland about 1769 and later spread throughout the southern states and southern portions of the northern states. It is, therefore, a very old pest and one that has done incalculable damage from time to time in the past and which will continue its ravages to a serious extent where allowed to multiply. The insect attacks all the cereals although it undoubtedly prefers corn and wheat. Certainly it does its greatest injury to these cereals in Maryland.

It is difficult to estimate the amount of loss that the pest occasions in this State annually. The loss through its attack on these cereals is not confined to farmers alone, but also to traders and millers. Several cases were reported last year where wholesale grain dealers purchased to be delivered at a central point car loads of wheat from sections that were infested with the pest. The usual delay in delivery furnished a sufficient period for the pest to multiply abundantly. Thus upon examining the wheat at delivery, a large per cent had been injured and immediate treatment was necessary in order to save the remainder.

The greatest losses were reported from Carroll and Harford counties, although much injury was reported to stored grain in many of the Eastern Shore counties. In the former the principal injury was done by the moth attacking it before the wheat was threshed and while stored in the barn.

A conservative estimate places the loss from this one insect the last year in the two counties above mentioned at from thirty to forty thousand dollars. Particular attention then should be given by the growers of that region in applying the remedies suggested for the pest.

DESCRIPTION AND LIFE HISTORY.

The adult moth is small and of delicate structure, resembling markedly the adult of the clothes moth. It is light grayish brown in color more or less lined and spotted with black and has an expanse of about one-half of an inch, as shown in Figure 1.

Fig. 1—The Angoumois Grain-Moth, (Sitotroga cerealella). a, full-grown larva; b, pupa; c, moth; d, wings of a paler variety—all enlarged; f, grain of corn cut open to show larva at work—natural size; g, labial palpus of moth; eggs; h, anal segment of pupa—all greatly enlarged. (After Riley in Ann. Rept. Depr. Agr., 1884).

The larvae are smooth and white with a brownish head. They are very active and may be seen crawling over the grain they infest before entering the kernels. The eggs are white when first laid but turn reddish before hatching. They are delicate, flat and oval and usually are found in clusters of 25 to 30.

The adult moth deposits its eggs upon the grain while standing or after it is stored in barn, bin or crib. The eggs hatch in from four to seven days and the tiny white larvae soon seek tender places and bore into the kernels of grain leaving almost imperceptible openings. Usually only a single larva will inhabit a grain of the smaller cereals such as wheat while two or more may be developed in a grain of corn. Feeding upon the farinaceous matter within the grain the larva develops, reaching maturity in three weeks or more according to climate, when it cuts a circular hole in the grain for the exit of the future moth. The larva then spins a silken cocoon in which it transforms to the pupa stage and in a few days the adult moth emerges from the previously prepared hole. Thus the entire life history is passed in about five weeks in a warm climate. After copulation the moths deposit their eggs for another brood and thus multiply throughout the season. Figure 1 illustrates each stage of the insect herewith described.

In Maryland, there may be as many as four generations, the insect passing the winter in the larva stage within the grain. As soon as spring opens it becomes active, the first moths appearing usually in May, depending upon the season.

In the southern states, or even in this latitude if grain is stored in a warm atmosphere, reproduction may continue during the winter months. At College we have been compelled to combat the pest in the depth of winter, as it bred continuously in seed corn stored in warm laboratories.

NATURE OF INJURY.

As indicated heretofore, the injury occasioned by this pest consists in the loss in weight of grain. Also its germinative power is destroyed and the qualities necessary for nourishing food are removed.

This is true in its attack upon all cereals. The amount of injury caused by the moth depends upon the manner in which the grain is stored and the degree of infestation at the start. The pest will do more injury to corn housed on the ear than if shelled early, for when on the ear there are spaces between the ears in the pile which allow the moths to escape, while if shelled grain is stored in deep piles only the immediate surface can be destroyed. Fig. 2 illustrates how an ear of corn can be ruined by the pest.

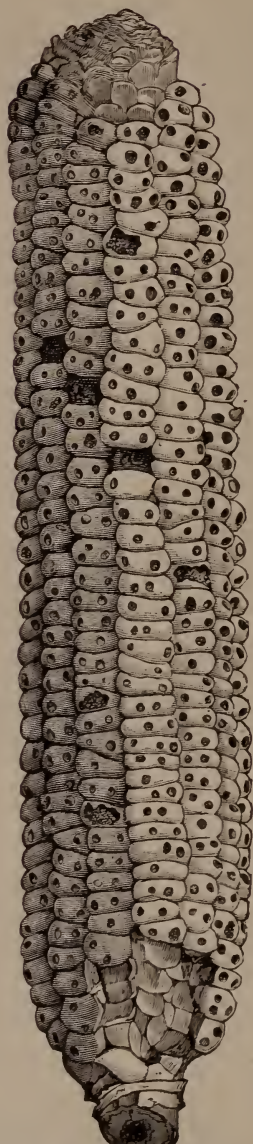

Fig. 2—Ear of pop-corn showing work of Angoumois grain-moth (from Riley in Ann. Rept. Dept. Agr., 1848).

The same may be said in regard to wheat, except that there is a greater opportunity offered for the pest to attack this cereal in the field than in the case of corn, as the former matures much earlier in the season than the latter. Especial opportunities are given the pest

when the wheat is stored unthreshed in the barn, or allowed to remain in the field for any great length of time before threshing.

REMEDIAL AND PREVENTIVE MEASURES.

In controlling the ravages of the Angoumois grain-moth, as well as many other of our stored grain pests, both preventive and remedial measures must be employed. Little can be accomplished by insecticidal treatment, if conditions favorable to their increase continue to exist.

Cleanliness of storage places is a prerequisite in preventing the injury from these pests. Dust, dirt and refuse material containing floor sweepings should not be allowed to accumulate in a granary, for such furnishes a breeding place for various pests. The floor of the granary or store-house should be frequently swept and worthless material burned. New grain should never be placed in a barn or bin where "weeviled" grain has been kept without having been thoroughly cleaned and perhaps fumigated in cases of bad infestation.

As the Angoumois grain moth attacks wheat in the field, wheat should be harvested as soon as ripe, and threshed as soon afterwards as possible. The growers of this crop in Western Maryland must discontinue the practice of either stacking their wheat in the field or storing it away in the barn to be threshed some time during late fall or in the winter, if injury from this pest is to be prevented. Even if some of the wheat is attacked by the moth in the field, threshing at an early date will accomplish much in killing many of the moths through agitation, and much infested grain will be blown out with the chaff and dust. When the grain is known to be infested at time of threshing it should be thoroughly fanned and fumigated before it is stored. In such cases the growers should have a quarantine bin, in which the new wheat may be treated with carbon-bisulphide, as it is impossible through the process of threshing and fanning to get rid of all kernels of grain in which a larva or pupa of the moth may be located. Further, in such suspected cases the grain should be stored in as large a bulk as possible without causing it to heat. The moth cannot gain much headway in the bulk of wheat on account of the inability of the adults to escape, and thus the surface layers only are exposed to infestation. This method is also applicable in preventing injury by some other grain pests. The frequent handling of grain is ofttimes advantageous to the insect's increase. Although such handling will kill many moths, yet it furnishes a new surface of wheat for those which extricate themselves to deposit eggs.

Finally, grain should be stored in a cool place, where artificial heat is not necessary for other purposes; for, as mentioned heretofore, if the grain is exposed to a warm atmosphere the insect will continue breeding throughout winter.

Equal precautions should be practiced in storing corn. Fortunately, this cereal is usually stored in a crib, exposing it to outdoor atmosphere. However, much damage can be done even under these

circumstances if the crib had been previously infested by the moth, or the corn attacked before being stored. In either case, the grain should be subjected to similar treatment as suggested for wheat.

Millers and tradesmen securing either of these cereals from the field, that is, just after harvest, should be particularly careful to examine the grain for the presence of this pest, lest serious injury, as was reported last year, may follow its uninterrupted reproduction.

The use of napthalene balls as a repellent can be recommended for bins and other enclosures, as the fumes of this deterrent will usually prevent the adult moths from depositing eggs upon the grain.

In early times subjecting infested grain to intense heat, or passing it through a patented shaking machine at a high temperature, were considered to be the best remedies. The first was often found to be impracticable, and the latter too expensive. Fumigation with carbon-bisulphide was then recommended, and this treatment now constitutes the best remedy to employ for treatment of infested grain.

CARBON-BISULPHIDE.

Carbon-bisulphide is a colorless, volatile liquid, with a strong, disagreeable odor. The liquid evaporates very rapidly at ordinary temperature, the gas being deadly to animal life exposed in it for any length of time. The vapor is heavier than air, and is therefore especially useful in fumigating grain. It is exceedingly inflammable; therefore, no fire of any kind, such as a lighted cigar, lantern, etc., should be permitted in the vicinity when fumigating with this gas.

In treating grain infested with the Angoumois grain moth, or similar pests of stored grains, the bisulphide is usually placed in shallow dishes or pans, and distributed about on the surface. The liquid evaporates in a short while, the vapor descending into the mass of grain. Spraying or pouring the chemical upon grain on any kind of seed will not injure its germinative power, nor make it unfit for food.

In fumigating grain or other products they should be placed in either a tight bin or room, which should be made as air tight as is possible. Any person may apply the chemical, as inhaling the small amount of gas necessary in filling the pans is not injurious. Infested grain, or if free and being fumigated as a preventive, should be exposed to the gas for about twenty-four hours when used at the regular recommended strength of one pound, or a pound and a half, to 100 bushels of grain, or the same quantity to 1,000 cubic feet of space. A much longer exposure at this strength will not injure it for milling purposes, but if exposed for more than thirty-six hours at a time its germinating power may be impaired. In bad cases the writer used with success double the above strength in fumigating infested corn, where the enclosure was not as tight as it should have been.

Carbon-bisulphide is an effective, easily applied and comparatively cheap remedy for all pests of stored products, and especially for the Angoumois grain moth and other grain weevils. Carbon-bisulphide is sold by all drug stores, but if much of it is to be secured it is far

more economical to buy in wholesale lots. It can be secured from the following manufacturing chemists:

E. R. Taylor, Pen Yan, New York.
Billings-Clapp Co., Boston, Mass.
Chas. Cooper & Co., New York City.
Geo. A. Bekenbrich Co., New York City.
Powers, Weightman, Rosengarten Co., Philadelphia, Pa.

CONCLUSION.

The Angoumois grain moth is generally disseminated throughout the State of Maryland. Many growers of wheat and corn have already experienced much loss from this pest. The pest can be easily controlled if the preventive and remedial measures suggested in this bulletin are employed. Particular attention should be given by growers to the preventive measures of threshing out grain as early as possible after harvesting, and much more attention should be given to keeping the corn crib and granary free from dirt or other accumulative matter in which this, as well as other granary weevils, exist.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 138 **AUGUST 1909.**

THE POULTRY INDUSTRY IN MARYLAND WITH SUGGESTIONS FOR SUCCESSFUL POULTRY MANAGEMENT.

By C. L. Opperman.

INTRODUCTION.

This bulletin has been prepared with the object of encouraging the poultry industry in this State. During the month of January the writer visited a number of poultry farms in different parts of the State; the object in view was to investigate the methods of those engaged in the industry, especially as to their commercial and practical value, so as to learn whether they are successful, and, if so, what factors contribute to that success.

The results of his observations, and other supplementary matter, are contained in the following pages, and he trusts that it will be of practical value to those already engaged in the business, as well as to those who may be contemplating engaging in the industry.

THE IMPORTANCE OF THE INDUSTRY IN MARYLAND.

Number of Poultry on Farms, 1880, 1890 *and* 1900.

Year.	Chickens.	Turkeys.	Geese.	Ducks.	Total.
1880	....	....	....	....	1,457,725
1890	3,430,859	278,522	91,238	232,519	4,033,138
1900	2,113,544	101,782	33,389	56,930	a2,305,645

a. Does not include fowls under three months old.

Production of eggs, 1879, 1889 *and* 1899.

1879 .... 4,984,776 dozens of Eggs.
1889 .... 8,718,593 dozens of Eggs.
1899 ....12,511,450 dozens of Eggs.

U. S. Census of Poultry and Eggs in Maryland, 1900.

	POULTRY AND EGGS.						
	No. of Fowls 3 Months Old and Over, June 1, 1900.				Value of All Poultry June 1, 1900.	Value of Poultry Raised in 1899.	Dozens of Eggs Produced in 1899.
	Chickens Including Guinea Fowls.	Turkeys.	Geese.	Ducks.			
The State	2,113,544	101,782	33,389	56,930	$1,158,020	$2,007,490	12,511.450
Allegany County	34,611	1,163	89	488	12,590	$21,135	$161,970
Anne Arundel County	56,753	3,403	508	1,953	36,634	73,791	278,880
Baltimore County	218,733	5,202	902	3,515	106,344	161,219	1,302,600
Baltimore City	2,538	36	3	105	1,113	1.095	16,460
Calvert County	40,671	11,552	677	814	22,716	33,417	96,350
Caroline County	81,335	3,220	621	1,048	$51,374	$ 93,184	553,920
Carroll County	199,255	3,111	421	1,411	81,600	115,285	1,301,170
Cecil County	91,704	3,831	1,241	3,241	49,227	93,214	449,970
Charles County	64,654	6,063	701	1.545	43,199	79,230	373,610
Dorchester County	71,977	2,860	2,325	6,799	48,768	93,069	455,300
Frederick County	233,900	5,304	1,104	3,075	$101,411	$175,512	1,564,560
Garrett County	54,102	3,136	213	837	19,022	31,329	253,440
Harford County	117,872	4,085	1,351	1,737	61,393	116,107	775,210
Howard County	64,107	2,629	261	1,198	34,829	52,997	394,780
Kent County	61,121	4,830	2,645	3,822	36,397	80,431	259,380
Montgomery County	111,637	4,294	764	1,670	$71,695	$90,191	718,840
Prince George County	95,218	5,396	533	2,217	51,534	96,436	484,240
Queen Anne County	58,596	5,447	3,878	2,749	49,395	104,595	267,480
St. Mary's County	45,874	7,009	1,909	2,594	34,735	67,445	249,400
Somerset County	49,345	2,419	2,617	3,943	38,448	72,107	220,280
Talbot County	50,036	4,436	3,884	4,291	$42,999	$91,284	295,240
Washington County	143,134	4,132	540	1,544	54,214	88,274	878,690
Wicomico County	85,655	2,279	1,114	2,880	46,433	82,107	598,400
Worcester County	80,716	5,945	5,178	3,454	61,950	124,009	561,280

While the value of poultry in Maryland was given at $1,158,020, the value of poultry products for one year was $3,650,170. Of this sum $2,077,490 was for poultry, and $1,572,682 was for eggs.

The total value of animal products for 1899 was $13,606,450, and poultry and eggs represented 26.8 per cent. of this sum. No other item among the animal products was so large in value, except dairy products, which amounted to $5,228,698, or $1,478,528 more than the value of poultry and eggs.

While the number of poultry was shown to be 1,727,493 fewer in 1900 than in 1890, due to the condition stated in the footnote to the table, the number of dozens of eggs produced increased from 8,718,593 in 1889 to 12,511,450 in 1899. The average price of eggs produced in 1899 was 12.6 cents per dozen.

Some reports of other leading products of the farm are copied herewith in order to show the relative importance of the poultry industry.

Corn	$7,462,594.
Wheat	6,484,088.
Dairy Products	5,228,698
Hay and Forage	4,709,072
Miscellaneous Vegetables	4,354,000.
Poultry and Eggs	3,650,172.
Animals Sold	2,372,560.
Animals Slaughtered	2,173,197.

One has but to study these tables to fully realize what a large part poultry occupies in the agricultural products of the State. The industry is showing a steady increase from year to year, and the demand for high-grade products far exceeds the supply of the present day. This was found to be true in every instance where persons were engaged in shipping high-grade products. The rapidly increasing population of towns and cities causes an increasing demand that it is practically impossible to supply.

When we consider that fully 90 per cent. of the poultry products come directly from the farm, where they are produced without any particular effort to get the best possible returns from poultry, it is remarkable.

That the industry has received very little attention until recent years is clearly shown by the United States Census for 1903, which credits the Maryland hen with only 70 eggs per year. The records of hens kept at Experiment Station has demonstrated that with better care, and improved methods of breeding, more than double this number of eggs should be produced.

NOTE—The foregoing statistics were compiled from the United States Census for 1900, and Circular No. 73, Bureau of Animal Industry.

METHODS OF HOUSING.

A few years ago the open-front poultry house was practically unknown. The tendency at that time was to construct houses that were very tight, and ventilated by the opening of windows, and in many instances by means of flues and cupolas. This type of house as a rule was more or less damp, and it did not take many years for progressive men to realize that damp houses meant cold houses, and an abundance of disease. The result has been a gradual increase of the amount of fresh air in the house, and less attention given to warmth, until today we have what is known as the open or cloth-front house. One can still find, however, many types of poultry houses, but the open-front house is fast becoming the standard for every climate.

The beneficial effects of a dry house with an abundance of fresh air, has been very forcibly demonstrated by several Experiment Stations. Professor Graham, of the Agricultural College at Guleph, states that, after careful tests made with warmed buildings, with double-wall houses having curtains before the perches and six feet away next to the wire netting; he has found that the one-ply board houses with netted fronts has given better results both as to the number of eggs produced in winter, and of the fertility and vigor of germs.

The open front house can be modified to meet a wide range of climate. In the northern states the house is generally equipped with a curtain front, and hooded roost. These curtains are dropped at night to insure a warmer house while the fowls are inactive. Whether the curtain front and hooded roost are necessary in Maryland is a question for further experimental work. The Experiment Station at the present time is conducting experiments relative to the necessity of these curtains.

In different parts of the State where new buildings are being erected, the open front, or fresh air idea was in evidence. There is little doubt but that the open front house is one big step toward putting the poultry industry on a firmer basis, and for houses of all sizes, this type of house is strongly recommended.

CONTINUOUS HOUSES.

With the exception of one or two instances, all the large poultry plants that were visited were using the continuous house system, due to the fact that it brings the question of labor down to the minimum, and there is no doubt but that this is one of the most important factors on a large poultry farm. It also means a great saving in the lumber bills, for example, if there were ten houses and the ends of each house contained 100 square feet of lumber; by bringing these ten houses together and making one continuous house, there would be a saving of 1000 square feet of lumber.

There are also some disadvantages to the continuous house, namely, (a) restricted yards, (b) disease, (c) subject to draft. In the majority of cases where the continuous houses are used the yard space is very much restricted, and it takes but a short time for the ground to become tainted and foul, which in time will bring about disastrous results and in some instances failure. Should disease break out in one of of the pens it is almost certain to infect the entire house; this would not be true where fowls were kept in small colonies. Long houses are more or less subject to drafts, but this can be greatly overcome by building board partitions every 20 or 30 feet.

In figure 1 is shown one of the very best types of a continuous house. It is 100 feet long by 20 feet wide, 9 feet high in the front and 6 feet in the rear. It is divided into five pens 20x20 feet, with solid board

Fig 1.—An excellent type of continuous open-front, shed-roof house on Mr. McGraw's farm, Hagerstown, Md.

partitions between each pen. One bird is allowed to every 4 square feet of floor space. The front or south side of each pen is boarded to a height of 4½ feet from the floor, with a single thickness of flooring; the remainder of the space, with the exception of two 12 light sashes which are placed one in each end of the front wall, is open and equipped with a cloth curtain. The curtain is dropped every night in cold weather and on stormy days. The windows are never opened but used as a source of light when the curtain is down. Each pen is equipped with a hooded roost extending the entire length of the pen, this is the only part of the house that is sealed on the inside of the studs. The

roost is provided with a cloth curtain which is dropped on very cold nights. Two small holes with sliding doors are used to ventilate the roost when the curtain is down. The floor consists of a layer of sheathing, then a layer of building paper and flooring. The outside of the studs on the ends and back are first covered with a layer of sheathing, then a layer of building paper and novelty siding. The inside of the studs with the exception of the hooded roost are entirely open. The nests are placed on the end walls and partitions.

The entire building rests on brick piers about two feet from the ground, and each pen is equipped with a trap door which allows the hen to go down and wallow in the dirt under the house. The chickens kept in this house were as happy and healthy as any found in the State.

Fig. 2.—An excellent type of continuous open-front, double-pitch roof house, Myers Bros.' farm, Havre de Grace, Md. Note the feed room on far end.

In figure 2, is shown another excellent type of continuous house. It is 240 feet long by 20 feet wide. The front wall is 6½ feet and the rear wall 5 feet high from the floor to the plate. The roof is of unequal span, the ridge being 7 feet in from the front wall, and the height of the ridge above the floor is 9 feet. The sills are 2x6 inch material placed broad side down, and rest on a concrete foundation. The floor is of earth and filled in several inches above the ground level. The rest of the frame of the building, with the exception of the rafters on the long slope of the roof which are 2x6 inch material, consists of 2x4 inch material. The entire building is single boarded and covered with Pariod Roofing.

The house is divided into twelve 20x20 foot pens. In the front or south side of each pen is one 12 light window, and a door 2 feet 6 inches wide with a 6 light window in the top. The space between the door and windows, 2½ feet from the floor, and 6 inches from the plate, is 2 feet wide and 10 feet long. This opening is fitted with a frame covered with wire, into which a frame covered with cloth is fitted. The frames swing in and down, on account of the overhead trolley which runs the entire length of the building. The cloth curtain is always open except on stormy days and winter nights. Each pen will accommodate 100 birds, thus allotting 4 square feet for each bird. A roost platform 3 feet 9 inches wide and 2 feet 3 inches above the floor, extends along the entire rear wall of the pen. Three perches of 2 by 2 inch material are rounded, and placed on edge 8 inches above the platform. The rear perch is 8 inches from the back wall, and the space between the perches is 12 inches. There is no curtain used in front of the roost.

The nests are placed on the partition walls. Several hoppers for shell, grit, bone and dry mash, are placed on the end wall and partitions. The building is equipped with the Kewanee water system and water piped to every pen. The doors between the pens are of single board construction, and swing on double acting hinges so as to open in either direction. Tight board partitions are used between pens to avoid draft.

On the far end of the building will be seen a two-story feed house. The feed is stored in bins on the second floor, and let down by means

Fig. 3.—A long breeding house, with feed room on one end, Mr. Wright's farm, Cockeysville, Md.

of shoots. An overhead trolley starting from the feed room and running the entire length of the building, is used to supply feed, and to do cleaning of various kinds. It is a great labor saver and will ultimately pay for itself.

The house has two large yards, this is a very good feature as it allows each hen just six times as much space to range on, than she would have with the single yard for each pen. At the time of the visit there were 1200 Leghorns in this house, and not one showed a frosted comb or disease of any kind.

Fig. 4.—A type of continuous house that would be more efficient if facing exactly opposite.

In figures 3 and 4 are shown two other types of continuous houses. Figure 3 would be much better if more provision was made for ventilation. Figure 4 has plenty of ventilation but should be facing exactly opposite, this would throw the high side to the south and thereby receive twice as much sunlight as it now gets. It would also place the roosts in the lowest part of the house and the fowls would not be subject to quite as much exposure during the night.

In figure 5 is shown a two-story poultry house accommodating 2000 mature fowls. The house is divided into two sections, with 1000 hens in each section. The entire second story is used for roosting room and nests. The perches are made of 2x2 inch material and rounded on the top, they are 5 feet 6 inches long, and placed on iron rods 18 inches above the floor, they are placed 22 inches apart from centers and arranged in groupes of 6. The entire floor of the second story is covered with about 6 inches of clean dry earth. The droppings fall

directly on this earth, and are removed with an ordinary hand rake. The roosting room is ventilated by windows and openings which are in both ends of the building.

Fig. 5.—A two-story continuous house, accommodating 2,000 laying hens, Belle Hill farm, Elkton, Md.

The ground floor is used for a scratching shed and feed room. Water is piped to the centre of the building, and 8 inch gutter troughs 20 feet long are used as water pans for the fowls.

Fig. 6.—A type of continuous house on Mr. H. W. Taylor's farm, Berlin, Md.

There are two of these houses on the farm and the manager is well pleased with them. There is probably no other house of this kind in the State and it gives some idea of the possibilities of keeping 1000 hens in a single flock.

In figure 6 is shown another type of front for a continuous house. The entire building is covered with tar paper which the owner said was very unsatisfactory, as it needed constant repairing.

SMALL STATIONARY HOUSES.

On many farms where poultry is carried on as an adjunct to the other farm crops, is found a variety of small stationary houses. There are several advantages in favor of the small stationary house. Where land is restricted, it is possible to provide a system of cultivation where the houses are small and set far enough apart to permit of double yards. These yards can be cropped alternately, and thus do away with the danger of tainted soil. In many instances very hilly land, that will not permit the construction of long houses, can be utilized to a good advantage with the small stationary house. In figure 12, is shown a very good illustration of this condition. Figures 7 to 12 show a variety of small stationary houses.

Fig. 7.—A stationary scratching shed house on Mr. Ide's farm, Woodstock, Md.

Fig. 8.—Views of small stationary laying houses on Mr. Hunter's farm, Vienna, Va.

Figure 9.

Figs. 9 and 10.—Two views of small stationary houses on Friedel Bros.' farm, Reisterstown, Md. Fifteen hundred Brown Leghorn hens are kept on this farm, and the owners are making a success of the business hen.

Fig. 11.—Two types of small stationary scratching shed houses, Mr. Wright's farm, Cockeysville, Md.

Fig. 12.—View on Mr. Wright's farm, showing how hilly land can be used to advantage with small stationary houses.

Fig. 13.—View of colony houses on Mr. Bryan's farm, Havre de Grace, Md.

THE COLONY HOUSE SYSTEM.

To give the reader an idea of the "colony house system" as practiced in other parts of the country, a description of the "The Little Compton District" of Rhode Island, by Edward S. Brown, and taken from the report of "The Poutlry Industry In America" is given below. Mr. Brown is Secretary to the "National Poultry Organization Society of England," and a man of world-wide experience.

The district as you will note from the description, is famous for the colony house system, and there probably is no other part of the country that would give a more practical illustration of the successful raising of poultry by this system.

*RHODE ISLAND COLONY FARMS.—One of the most instructive and interesting periods of my tour was that spent in the Tiverton and Little Compton district of Rhode Island, for there was seen in operation a system most successful, in that it is conducted upon rational lines, and appears to be suitable for adoption elsewhere. Respecting it very little is known, even in America. I was fortunate in having as guide Mr. J. H. Robinson, editor of "Farm Poultry," of Boston, Mass., who has within the last five years frequently visited the section and called attention in his paper to the system adopted. The district is part of a tongue of land lying between the Sakonnet river on the west and an arm of the sea on the east, the sea rounding it off to the south. Thus it is surrounded by water on three sides, from which we have the explanation of the comparatively mild winters and the small snowfall which are experienced. Within a few miles is Newport, the famous seaside resort of wealthy Americans. The land consists of a fairly good soil, but is almost bare of trees, is wind swept, and the stone fences dividing the fields—a rarity in America—show that at one time it must have been well covered with stone. Starting at Tiverton, a few miles below Fall River, Mass., we drove a distance of more than 25 miles, and I have never seen, even in Sussex or France, so many poultry houses or fowls upon the same area. For America it is a unique spectacle. Within half a dozen miles of Little Compton in every direction there are scores of farms where poultry are kept and raised in large numbers, hundreds of poultry houses can be seen from the roadway in the course of a mile or two, and it is estimated that half a million hens are kept within that radius. This is the district where has been evolved the race known as the Rhode Island Red, and nearly all the fowls are more or less of that breed. The methods adopted and the houses used are wonderfully uniform, almost monotonous. But these afford an example of what can be done in practical poultry keeping over a long period of time, for the section has been strong in poultry for sixty years, though the increased production has been most marked within the last two decades. The main idea is egg production, as the Rhode Island Reds produce good-sized eggs, deeply tinted in shell, and are in large demand upon the Boston and Massachusetts markets. The Reds do not, however, appear to be heavy layers, yet they yield a satisfactory profit to their owners. Large quantities of geese are also bred in the district. The people are shrewd, quiet, somewhat reserved, but essentially practical, and differ greatly from those found in the manufacturing towns a few miles away. The farms are usually from 60 to 100 acres in extent, consisting of both pasture and arable land. The former is used for feeding stock, or is cropped for hay, and the latter is cultivated for grain. In many cases the fields are small, reminding us of certain districts of England.

RHODE ISLAND COLONY HOUSES.—It is desirable to remember that whilst the number of fowls kept upon these Rhode Island farms is large, and to some extent the methods adopted are intensive, the poultry section is but part of the farming operations—an important, even a leading part. Almost entirely the poultry houses are small, and there is an entire absence of the large structures seen upon the big poultry plants previously described. The Colony system was first introduced about sixty years ago, and extensions have been entirely along these lines. So far have the original methods been retained that very few incubators are used, and only upon one place I visited is a brooder house employed. Hatching and rearing is almost universally natural, not artificial. This is possible from the fact that early hatching is not attempted, because there is no need to bring out chicks other than at the regular season, generally in April. The Rhode Island Red is an excellent sitter and mother. I was informed that when broody hens are required they are always available. The houses are generally 8 ft. by 12 ft. and 6 ft. high, with gabled roofs, are provided with large windows in front, a 30 in. door, and the usual trap entrance for the hens. Inside tney are fitted with perches and nests, and as they have no floor the earth is thickly covered with sea sand. In the majority of cases cattle are kept on the same fields as the fowls, and, wnere that is so, it is customary to put a rail fence around the houses to keep the stock away from the water vessels and food troughs. Each house is designed to hold 35 to 40 fowls, and the customary plan is to allow one such house to the acre. But the whole farm is not thus occupied by poultry, for portions are devoted to rearing and others to ordinary cultivation. For instance, Mr. Fred Almy, of Little Compton, who has been engaged in this work for fourteen years, and has made a good living and more at it, so much so that, in reply to a question he indicated he is satisfied and prosperous, owns

120 acres of land, and keeps 1,800 laying hens, so that 45 acres are used for laying stock. He showed me one field which has been occupied by the layers for 12 years, and there is no sign of taint, but it is fed with stock or cropped annually. This bears out what we have found in England, namely, that the danger point is when we get beyond 40 fowls per acre. The farm of Mr. W. N. Sissons, at Little Compton, consists of 65 acres, and he keeps 1,500 layers. These are fair examples of many others. Mr. Almy assured me that it was most important to change the rearing ground for chickens every year, but under the method named such change is not needed for adults. This season he has raised nearly 3,000 chickens, and reared 1,000 on a field not exceeding two and one-half acres. The point which I wish to emphasize is that this district proves the practicability of poultry keeping by farmers upon a much larger scale than has hitherto been attempted in England, as part of the general work on the farm, and that it has proved successful for a long series of years in a large number of cases. But due care has to be paid to avoidance of overstocking and prevention of tainted soil. The profit acknowledged by some of the breeders is $1 (4s. 2d.) per hen per annum, which is satisfactory, considering that the Rhode Island Reds do not lay more than 100 eggs in the twelve months. The cost of feeding is much less than on the larger plants, for the hens obtain a large amount of natural food, and as much as possible is grown in the spot. It is estimated at 80 cents (3s. 4d.) per head per annum. The returns would be greater if more prolific fowls were kept, but if non-sitters or late sitters were employed, provision would be necessary in the shape of incubators and brooders, with a corresponding increase in the capital required, and the cost of management and labor. It is also to be remembered that foxes are unknown in that section, and other enemies have been exterminated.

Only one farm was found in Maryland where the true colony system was being used. This farm was that of Chas. E. Bryan, Havre de Grace, Maryland, where from 2500 to 3000 laying hens are kept in colony houses. The stock was mostly White Leghorns as eggs were the main object on this farm.

In figure 13 is shown a row of these houses, they are 12 feet long, by 7 feet wide, 6 feet high in the front and 4 feet in the rear. In the front wall there is a door 2 feet 6 inches wide, with a 6 light window on either side. They are built on runners 4x6 inches in size, with the broad side down. A detail description of these houses is given on page ......

There was about 75 of these houses scattered over various portions of the farm, and from 25 to 30 fowls in each house. Water and feed is supplied by means of a horse and cart.

At the time of the visit which was in the early part of January the fowls were in excellent health, and the egg production was about 40 per cent. These are strong arguments in favoring the colony house system, and would seem to be a good recommendation for their more general adoption where poultry is kept as an adjunct to the other farm crops.

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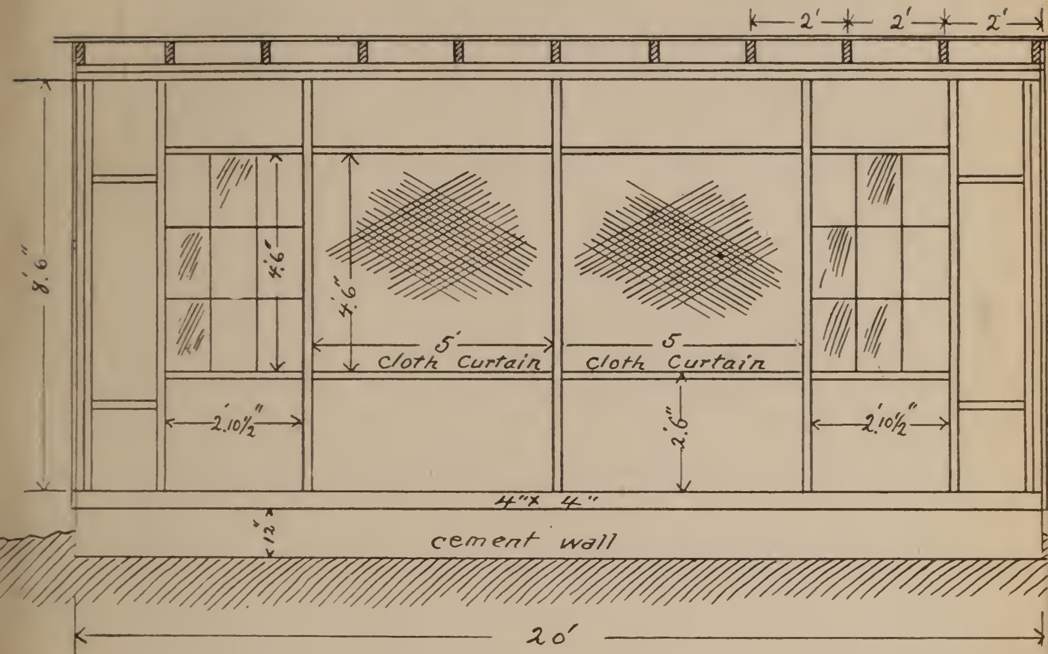
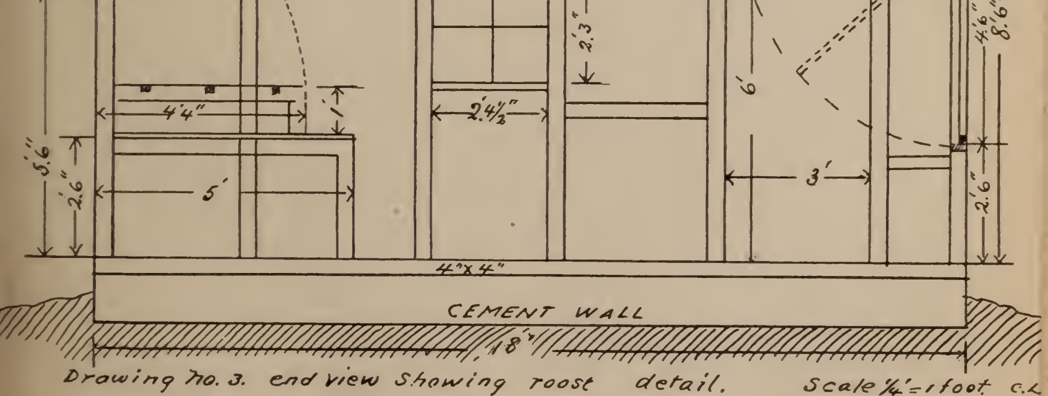
*The above article was taken from "The Report of the Poultry Industry In America."

A POULTRY HOUSE FOR MARYLAND.

In drawings 1, 2 and 3 is given a working drawing that can be followed in constructing the building. The house is 20 feet long by 18 feet wide, 8 feet 6 inches high in front and 5 feet 6 inches from sill to plate in the rear. The sills are 4x4 inches in size and rest on a cement foundation 6 inches wide. All studding is 2 by 4 in size and the rafters are 2 by 6. The building can be covered with German or Rustic siding or rough boards and a good grade of roofing paper. The floor is of cement, which makes the best floor for the poultry house. The front or south side of the building has two windows of 12 lights of 10x12 glass, these are stationary and placed 1 foot 10½ inches from





Drawing No. 3. end view Showing roost detail. Scale ¼'=1 foot. C.L.

each end of the building. They are 2 feet 6 inches from the floor. The space between the windows is 10 feet long and 4 feet 6 inches wide, this space is not boarded, but left open to be covered by the cloth curtain when necessary. This leaves a tight wall 2 feet 6 inches high, extending from the bottom of the opening down to the floor, which prevents the wind or storm from blowing directly on the birds when they are on the floor. Two light frames, made of 1 by 3 inch pine strips, are covered with sheating, and hinged at the top of the front opening, which it covers when closed down. When the curtain is up it is held by hooks fastened to the rafters.

The roost platform is made tight and extends along the whole length of the rear wall. It is 5 feet wide and 2 feet 6 inches from the floor, high enough to permit the sunlight to sweep under and to allow a person to catch or handle the birds. There are 3 roosts framed together in two 10 foot sections. They are 1 foot above the platform and hinged to the back wall so they may be turned up and out of the way when cleaning the platform. The back roost is 12 inches from the rear wall, and the space between each of the others is 16 inches. There is no curtain in front of the roost, but on cold nights the curtains in the front of the house are closed. The nests are placed on the side walls and may be constructed according to the ideas of the builder. On each end of the building and 1 foot 8 inches from the front wall, is a 3x6 foot door. There is also one 2 light sash of 12x24 glass in each end of the building, and they are used only during the summer months when they add greatly to the comfort of the birds. They are hinged at the top and swing out and up. The house will accommodate from 80 to 100 mature fowls.

BILL OF MATERIAL.

Floor and Foundation Wall.

8 barrels of cement.
3 yards clean coarse sand.
6 yards broken stone.

Sills.

6 pieces 4"x4"x10'
2 pieces 4"x4"x12'

Front Studding.

13 pieces 2"x4"x10'

Side Studding.

10 pieces 2"x4"x10'

Back Studding.

3 pieces 2"x4"x12'
2 pieces 2"x4"x10'

Plate.

4 pieces 2"x4"x12'
4 pieces 2"x4"x10'

Rafters.

10 pieces 2"x6"x20'

Roosts.

10 pieces 2"x4"x10'
150 square feet No. 3 flooring.

Siding.

650 square feet Novelty or German siding.

Roof Boards.

400 square feet rough lumber.

Windows.

2 windows (without frames) 3'. 10½"x4'. 6¼"
1 window (without frame) 2'. 4½"x4'. 6¼"

Miscellaneous.

450 square feet good grade roofing paper 2 or 3 ply.
3 gallons paint.
2 locks.
2 pair 6 inch strap hinges.
½ doz. 6 inch hooks and eyes.
3 pair 3 inch strap hinges.
20 lbs. 8 penny nails.
1 lb. 10 penny nails.
5 lbs. 20 penny nails.
1 lb. 6 penny finishing nails.

No set price has been fixed on this bill of material, owing to the variation of prices in different parts of the State. The finished house should not exceed $100 dollars in cost.

ARTIFICIAL AND NATURAL INCUBATION.

The remarkable growth of the poultry industry in the past few years, would not have been possible had it not been for the introduction of artificial methods of hatching and brooding; by means of which the breeding period of the year can be lengthened, and the market demand met to some some extent in the case of eggs by earlier hatched pullets, and in that of table chickens and ducklings by bringing the birds out during the winter and spring months. When we consider the large number of companies whose entire business is the manufacture of incubators and brooders, some idea of the rapid development of this branch of the industry is obtained. It is stated by good authority, that one firm sold during 1905 about 25,000 machines, which were shipped to all parts of the world.

Capacity of Plants—To meet the requirements of large plants hatching must be conducted on an extensive scale. On one of the farms visited there was in operation a mammoth incubator holding 6600 eggs; it is divided into 40 compartments and heated by hot water. At the Belle Hill Poultry Farm, Elkton, Md., 20 of the 220 egg machines are in use, holding 4440; at Mt. Pleasant Farm, Havre de Grace, Md., 13 incubators with a capacity of 4160 eggs are employed; on Mr. Taylor's Farm, Berlin, Md., there are 6 machines with a capacity of 1440; at Mr. Clark's Farm, Ellicott City, Md., there are 8 machines with a total capacity of 2200 eggs. These are but examples of many others that are located in different parts of the State.

Incubator Cellars—With one exception, the incubator cellars on the large poultry plants that were visited, have been built partly below ground. This is to insure a warmer building during the winter, and a cooler room in the summer. There is, however, no good reason why the incubator room cannot be above ground and give good results. On Mr. Taylor's Farm, Berlin, Md., the incubator room is above ground and his hatches average 60 to 70 per cent. of the total number of eggs set; which is as good as the results obtained from cellars that are partly below the ground.

One of the most important factors in successful incubation is an abundant supply of oxigen for the developing embryos, only obtained by them from sweet, fresh air. To get an abundance of fresh air where the cellar is partly below ground, is much more difficult than when it is level with the earth. It was a noticeable fact, however, except in one instance, that no special arrangement, outside of windows, had been made for ventilation; and it is very probable that a large per cent. of the mortality in incubator chicks is due to this condition. On the Mt. Pleasant Farm, Havre de Grace, Md., the incubator cellar is partly below ground, but is provided with an excellent system of ventilation. The building is shown in figure 14 and is constructed of stone which is very plentiful on this farm. The cellar is ventilated by means of flues in the wall, the air being taken in on the outside near the ceiling and enters the room about 8 inches from the floor. There are 6 of these flues and 7 windows all of which are used for supplying fresh air. In the photograph will be seen a galvanized iron chimney which extends well above the ridge of the roof. This chimney is 18 inches in diameter and used to draw off the impure gases, being regulated by a sliding door in the ceiling of the cellar. The manager stated that the hatches in this cellar would average 80 per cent. of the fertile eggs; and these results, when compared to the average of about 50 per cent. would seem to be proof of the necessity of an abundance of fresh air in the incubator cellar.

Moisture.

Moisture—During the past few years there has been a considerable amount of controversy with regard to the operation of incubators with, or without, moisture. In talking with poultrymen throughout the State, they were generally agreed, that moisture in some form is necessary.

Two Experiment Stations have published bulletins showing, that the machines which had moisture supplied gave larger hatches, and stronger chicks, than the machines which were operated without being supplied with more moisture than was contained in the atmosphere. The publication of this work has led some large incubator manufacturers to equip their machines with automatic moisture regulators, and there is no doubt that it is a great improvement on the non-moisture machines.

PRACTICAL SUGGESTIONS FOR OPERATING THE INCUBATOR.

Purchasing the Machine—Whether it will pay to buy incubators depends largely upon one's circumstances. Where chicks are desired in large numbers earlier than April, the incubator is a necessity as it is almost impossible to produce them by natural methods. In cases where chicks are hatched in May and June, the hen may be used very successfully. In the "Little Compton District" of Rhode Island, which has been described in the previous pages, practically all the hatching and brooding is done with hens and several of the farms in this district keep from 1000 to 1500 laying hens.

There are on the market a large variety of incubators and it is impossible to say what one will give the best results. The conditions under which a machine is operated has everything to do with the success of the hatch. The experienced man may take an inferior incubator and by his expert operation secure a good hatch; on the other hand an inexperienced man may take one of the best machines and through lack of knowledge make a complete failure. Below is given a list of the incubators that were found to be both popular and successful in this State.

1. Cyphers Incubator, Cyphers Co., Buffalo, N. Y.
2. Model Incubator, Chas. A. Cyphers, Ferrace and Henery Sts., Buffalo, N. Y.
3. Prairie State Incubator, Prairie State Incubator Co., Homer City, Pa.
4. Hall's Mammoth Incubator, Penbroke, N. Y.

No doubt there are many other machines on the market that will hatch as well as those mentioned above. These have been named because they have proven satisfactory and are in more general use in this State.

SELECTION AND CARE OF EGGS FOR HATCHING.

In selecting eggs for hatching use only those that are of uniform size and color, with smooth strong shells. Abnormal eggs are likely to produce weak or crippled chicks. The eggs should be stored in a room where the temperature ranges from 50 degrees to 60 degrees F. It has been a prevailing idea that eggs kept for hatching should be turned daily. Several men of authority claim that this is not necessary, but as this is not definitely proven, the eggs that are kept for a week or

more should be turned at least twice a week. It can do no harm and may prove beneficial. Never set dirty eggs, if they are dirty take a damp cloth and carefully wipe them until all spots are removed.

OPERATING THE INCUBATOR.

If the machine has just been purchased, it should be removed from the crate and assembled, care being exercised to follow the manufacturers directions for putting the various parts together. The next question is a suitable room in which the machine may be operated. In choosing a room select one that will allow for ample ventilation without a direct draft on the machine. Do not place the machine directly in front of a window, as the direct rays of the sun will make it difficult to control the temperature. A cellar that can be ventilated and that is not too damp, makes an excellent place for the machine.

For best results see that the machine is perfectly level; otherwise it will not distribute the heat evenly to all parts of the egg chamber. The lamp should be cleaned, and filled with a good grade of coal oil which will insure a steady flame and no smoke. The lamp should be lighted and placed in position, as it will require several hours to dry and warm the woodwork thoroughly. When the mercury in the thermometer registers 100 degrees it will be necessary to read the thermometer every 15 or 20 minutes in order to adjust the thumb-screw on the regulator. When the thermometer registers 102 degrees F. adjust the thumb-screw so the tin disk on the regulator arm will be just trembling on the rise. The machine should be run for at least 24 hours before putting the eggs in, this will give an opportunity to study the regulator, and see that the temperature remains steady.

The eggs are now placed in the machine and do not be alarmed if the mercury in the thermometer receeds from sight; this is easily accounted for by the fact that eggs are cold, and it will require several hours before the thermometer will again register 102 degrees. The eggs should not be disturbed until the third day, the only work required is cleaning and filling the lamp each morning. On the evening of the third day the eggs should be turned, and cooled for five minutes; be sure there is no grease on the hands when turning the eggs. After the third day turn and cool the eggs morning and evening, gradually increasing the amount of cooling as the hatch progresses.

The eggs should be tested on the seventh and fifteenth days. This may be done during the day if a dark room is available if not at night. The testing of eggs is very easy and after a little practice, one should experience no difficulty in distinguishing the good eggs from the bad. When held to the light a fertile egg can be distinguished by a small dark center, (which is the heart) from which blood vessels radiate in every direction .The infertile or sterile eggs will be perfectly clear when held up to the light. Eggs that contain dead germs, can be distinguished by a small dark center (sometimes this is lacking) surrounded by an irregular circle and the absence of blood vessels. When the eggs are tested on the fifteenth day, those that contain live chicks will ap-

pear, when held to the light, to be filled with a dark mass, which in reality is the developing embryo. The infertile egg should be saved and used in feeding the young chicks for the first few days; they may also be used for baking purposes as a slight evaporation is the only change that has resulted from incubation. The eggs should not be turned or cooled after the eighteenth day; close the machine and do not disturb it, except to fill and trim the lamp, until the hatch is complete. While the eggs are hatching the temperature of the machine may go as high as 105 degrees to 107 degrees; this is caused by the animal heat given off by the chicks, and no attempt should be made to lower the temperature if the machine had been running properly just previous to hatching.

Before reseting the machine clean and disinfect it thoroughly, put a new wick in the lamp, and operate it for a day or more in order to properly adjust the regulator.

SETTING THE HENS.

Where small flocks are kept incubation by the hen is the most satisfactory means of increasing or renewing the flock. A good nest for setting hens may be made in the following manner, take a box about 12 inches square and 6 inches deep, place an overturned sod or some fresh earth in the bottom, the nesting material is next put in and may consist of chaff, straw or hay about 3 inches deep. The nest should be placed

Fig. 14.—Incubator cellar and feed room on Mr. Bryan's farm, Havre de Grace, Md.

in a shed or pen where the other fowls cannot disturb it. When a broody hen is secured she should be placed on the nest after dark and allowed to set on several nest eggs until you are certain that she means business. Before setting the hen on good eggs give her a thorough dusting with some good insect powder, and at the same time sprinkling a small amount in the nest. While the hen is setting she will require very little green food; but plenty of grain, grit, shell and water should be kept before her at all times. If possible a dust bath of some form should be provided as it is a great help in keeping the lice away.

Fig. 15.—Incubator cellar, shipping room and brooder house combined, Mr. H. W. Taylor's farm, Berlin, Md.

ARTIFICIAL AND NATURAL BROODING.

No attempt shall be made to describe the various types of brooders that were inspected while on the trip, as this would make a book by itself; but a description of those that seem best adapted to general farming conditions is given.

LARGE BROODER HOUSES.

In figure 16 is shown a long continuous hot water brooder house. Figure 19 shows an interior view of this house. This is the type of brooder house that is used on large poultry plants, and a detailed description would be of very little value to the average reader.

In figure 15 is shown a continuous brooder house combined with the incubator cellar. This house is equipped with individual brooders,

each one being heated separately by an oil lamp or stove. Each brooder has a small division or pen on the inside of the building, and a yard, corresponding to the pen, on the outside. The great advantage of the individual brooder is the fact, that each one may be run at a temperature desired by the operator; while with the hot water system, each hover is practically the same temperature. This type of brooder house was in use on several large poultry plants, and in most cases was equipped with home-made brooders patterned after some the manufactured brooders on the market.

Fig. 16.—Incubator cellar and brooder house combined, Belle Hill farm, Elkton, Md.

Fig. 17.—Incubator cellar on Myers Bros.' farm, Havre de Grace, Md,

THE COLONY BROODER HOUSE.

In figure 18 is shown a good type of colony brooder house. In figure 13 is shown another size of this style brooder house. For general farm conditions this style of brooder house is strongly recommended. The advantages are: (a) An excellent colony house for rearing the chicks after they are through with the brooder; (b) May be used in winter for laying houses, or quarters for surplus stock; (c) Being movable gives each lot of chicks the advantage of fresh ground; (d) Can be equipped with almost any make of indoor brooder; (e) On rainy days the chicks have a large floor space to exercise on; (f) Is easy to keep clean and sanitary. The houses shown on figures 13 and 18 are equipped with the Prairie State Universal Hovers, which have proved very satisfactory.

The houses shown in figure 13 are 12 feet long by 7 feet wide, 6 feet high in the front and 4 feet in the rear. They are constructed after the plan of the "Maine Experiment Station Brooder House" of which a detail description is given below.

THE MAINE EXPERIMENT STATION BROODER HOUSE.

The house is 12 feet long and 7 feet wide. The front wall is 6 feet 2 inches high, and the back 4 feet 2 inches from the floor to roof, inside. This allows a full grown person to stand erect in the front part of the house. The two shoes on which it is built are 4x6 inches in size and lie flat. Their ends are chamfered on the under side so as to give them a sled runner turn. They are 14 feet long, and extend a foot outside of each end of the building. An inch auger hole slanting backward, and outward, is bored through each end of the shoe. For convenience in moving the houses, a short chain with an eye bolt in each end, which can be slipped through the auger hole and skyed, is used.

The floors are of two thickness of boards, breaking joints so as to prevent the air from drawing through. The walls and roof are boarded and covered with one of the better qualities of sheet roofing materials.

A door 2 feet wide and 6 feet high is placed in the center of the front wall with a window on each side of it. Each window contains 6 lights of 10 by 12 glass in one sash. It is hinged at the top and turns out, like an ordinary storm window. It is either closely buttoned down, or held open at different spaces, by hooks of various lengths. The longest opening is a foot, which leaves the window slanting out at an angle sufficient to give plenty of fresh air in warm weather when both windows are open, and the house full of birds. The advantage of hinged over sliding windows, are that in stormy weather, rain and winds do not beat in to wet or annoy the birds, and free ventilation is not interfered with. The window openings are covered with wire netting on the inside. A slide door, a foot square, is made down at the floor, near each end of the front of the building, for the chicks to pass through.

These portable houses are well made, of good material, and if the shoes are kept blocked up from the ground, they should last as long as other farm buildings.

After the chicks are through with the heat, the cockrels should be removed, which will leave from 50 to 75 pullets. The house will accommodate this number very nicely until they are ready for the laying pen.

OUTDOOR BROODERS.

There are several good outdoor brooders on the market, any one of which will give good results if properly operated. For persons with a small flock, and who do not wish to use hens, the outdoor brooder can be used to advantage. In figure 23, is shown a good type of outdoor brooder. It is made by the Prairie State Incubator Co., Homer City, Pa., and costs in the neighborhood of 18 dollars. It will accommodate about 60 chicks and being well made should last for several years. In figure 22 is shown a number of outdoor brooders with the chicks scattered over the hillside.

OPERATING THE BROODER.

The brooder should be started a day or so before the chicks are put in, this gives an opportunity to see that the lamp and heating apparatus are working properly. The temperature of the brooder for the first week should be between 95 degrees and 100 degrees F., lowering it at the rate of about 5 degrees each successive week. Watch the chicks' actions and you will soon learn to know whether they are too hot or too cold. When looking after them the last thing at night, if you see several heads sticking out beyond the hover, you can be certain that they are comfortable. If lamps are used see that they are cleaned and filled once a day, and in windy or stormy weather it is better to clean and fill twice a day. Clover or alfalfa chaff makes an excellent litter for the little fellows to scratch in; do not use such materials as sawdust or shavings. A young chick is very much like a baby, as it will try to eat anything that it can find, and the little fellows cannot be expected to make a rapid growth on sawdust and like materials. Keep the brooder clean and sanitary at all times; do not wait for disease before measures are taken to prevent it.

CARE OF HEN AND CHICKS.

When the hatch is complete, which is about 24 hours after the first chicks hatch, the hen and chicks should be removed to a dry clean coop with a sanded floor, and containing clover chaff or cut straw. If several broods are hatched on the same day, from 12 to 15 chicks may be given to each hen. It is not a good plan to put different colored chicks with a hen for unless she has hatched them, she is liable to kill those that do not suit her. The coop should be placed in the orchard or corn field, which makes an ideal range for growing chicks, as it admits plenty of sunshine and also provides ample shade.

Fig. 18.—A colony brooder house equipped with the Prairie State Universal House, Mr. Taylor's farm, Berlin, Md.

Fig. 19.—Interior view of a continuous hot water brooder house, Belle Hill farm, Elkton, Md.

Fig. 20.—Home-made brooder, Friedel Bros.'

Fig. 21.—Two views of a crude, but efficient, home-made broder, Friedel Bros.' farm, Reisterstown, Md.

SEPARATING THE SEXES.

When the chicks are eight or nine weeks old, the sexes should be separated, as each will do better when by themselves. The pullets are put on range and the cockrels fattened for market, or reared and sold as breeders.

FEEDING CHICKS.

The chicks should not be fed until they are 24 hours old. Nature has provided for this by the absorption of the egg yolk into the chicks' abdomen just previous to hatching, and it is essential that this food be assimilated before any other is given to them. Many people make a mistake by feeding the chicks before the system is ready to take care of it.

The first feed may consist of hard boiled eggs mixed with rolled oats or bread crumbs. Stale bread soaked in milk or skim milk is also good. After soaking, the milk should be squeezed out until the mass crumbles readily. A great many give commercial chick feed for the first feed, but it is well to give a little soft food of some form for the first day or two until the little things have learned to eat.

After the chicks are a few days old it is well to begin to feed a small amount of grain. Finely cracked corn and wheat, pinhead oat meal and millet seed may be scattered in the litter, or about the yard. Fully 75 per cent. of the poultrymen are using commercial chick food on account of the lack of proper machinery in the mills for cracking the grain.

The chicks should be fed a little at a time and often. The main object is to keep them busy from morning till night. For the first week feed about four times a day, giving just what they will eat up clean, except at night when they should be allowed to have all they want. Care should be exercised not to force them for the first few weeks, simply keep them growing. After the chicks are five or six weeks old, the finely cracked grain can be substituted with cracked corn and whole wheat. When they are removed from the brooder and put on free range, all food should be hopper fed as it saves a great amount of time and labor.

GREEN FOOD.

Green food should be supplied in some form from the start. If the chicks are ranging on young grass they will help themselves, but if confined to small coops or yards, green food should be given. Any of the following green foods are relished, and easily assimilated by the young chicks, onions and onion tops, lettuce leaves, lawn clippings and cabbage.

ANIMAL FOOD.

In most instances it is necessary to furnish animal food to the growing chicks. For young chicks there is nothing better than hard boiled eggs, or skim milk; and as the chicks grow older beef scrap or green cut bone may be fed.

GRIT.

Grit should be supplied as soon as the chicks are put in the brooder, and many people put a little in the food which is a very good method. A small hopper or box is an excellent way of keeping the grit before them.

WATER AND CHARCOAL.

A good supply of clean fresh water should be within easy reach at all times. A little charcoal is very good for keeping the digestive organs in proper condition.

METHODS OF SEVERAL POULTRYMEN FOR FEEDING CHICKS.

The following methods of feeding young chicks, were secured from successful men and women in different parts of the State. These methods are the personal experiences of those in the industry and represent various ideas, it is therefore obvious that the author is not responsible, except in the description of the method used at this Station, for any statement made therein.

METHOD I MARYLAND EXPERIMENT STATION.

Infertile eggs are boiled for half an hour and then mashed, or run through a meat chopper, shells included, they are then mixed with six times their bulk of rolled oats by rubbing together with the hands, a small amount of grit and pulverized charcoal is then added. This mixture is fed every two and one half hours for the first three days. About the fourth they are fed a commercial chick food as soon as it is light in the morning, care being taken to give just enough so that they will be hungry at 9 A. M. At 9 o'clock they are fed a mixture consisting of two parts by weight of rolled oats, two parts wheat bran, two parts corn meal, one part sifted beef scrap and half part linseed meal. This mixture is fed dry in troughs, and removed after it has been before them for ten minutes. At 12.30 the chick food is fed in the litter the same as in the morning, and 4.30 or 5 o'clock the dry meal mixture is fed giving all that they can eat. This is continued until the chicks are four or five weeks old, when the chick food is substituted by equal parts of cracked corn and wheat. When the chicks are six weeks old the dry meal mixture may be fed in hoppers, the grain being fed in the litter as before. As soon as the chicks are through with the brooders

and are put on free range, everything is hopper fed. The hoppers contain cracked corn and wheat, and the dry mash mixture that is fed to the laying hens, (see page 43). Grit, shell, bone and charcoal are kept in hoppers before them at all times. Some form of green food is given from the start; cabbage, onions, lawn clippings, etc., are all good. The forgoing method of feeding chicks has given good results at this Station.

METHOD II. MR. IDE, WOODSTOCK, MARYLAND.

The chicks are not fed until about 48 hours old. When hatched with hens they are placed with mother in a roomy coop with a board floor (never on dirt). At first they are fed three times a day with a mixture of equal parts of finely cracked corn, wheat and steel cut oats. This mixture is prepared on the farm. When about four weeks old they are fed on the same food with the exception that the corn is cracked somewhat coarse, and the wheat fed whole, grit, shell and charcoal are always before them. Beef scrap is fed sparingly after the chicks are eight weeks old, as the free feeding of beef scrap has shown a tendency to develop large coarse combs.

METHOD III. JOHN H. JONES, BROOKVILLE, MD.

The first three days the chicks are fed on commercial chick food, boiled eggs and stale bread. After the third day the commercial chick food is fed until they are large enough to eat cracked corn and wheat. At this age everything is hopper fed, the hoppers containing cracked corn, wheat, beef scraps, grit, shell and charcoal.

METHOD IV. MRS. ERP, BURTONVILLE, MD.

The chicks are not removed from the incubator until they are twenty-four hours old, they are then put in brooders which have an inch or more of clean white sand on the floor. The first day they are given warm separated milk (never cold) in the morning, and nothing more until afternoon when they are given a feed of Chas. A. Cyphers' Model Chick Food. For the next three days chick food is kept before them most of the time. After the third day feed chick food three times a day, giving just what they will eat up clean and be hungry for the next feed. Beef scrap is started about the sixth day and kept before them at all times. The chick food is continued until the chicks are large enough to swallow steamed wheat, the ration is then changed to chick feed in the morning, steamed wheat at noon, a light feed of cracked corn during the afternoon and steamed wheat at night. After the chicks are three weeks old they are fed mostly on steamed wheat, grit, shell, charcoal and beef scraps are kept before them at all times.

NOTE—The method of steaming the wheat is found on page 45.

METHOD V. GEORGE L STABLER, CASTLETON, MD.

Chicks are left in incubator until twenty-four hours old, they are then removed to the brooder house and receive nothing but grit and water the first day. The second day they are fed rolled or pin head oats three times during the day, giving only what they will eat up clean at each feed. This is continued until the chicks are a week old. They are then fed finely cracked wheat, meat meal and a dry mash consisting of equal parts by weight of corn chop, wheat bran and ship stuff. The dry mash is fed in hoppers where the chicks have free access to it at all times. This is continued until the chicks are six weeks old, at which time they are removed from the brooder house to colony houses, putting about 100 chicks in a house 5x10 feet, with a large brooder in one end. They are allowed free range until between four and five months old. The pullets are then put in the laying houses and the cockrels sold as broilers.

METHOD VI. DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

The chicks upon hatching are left in the machine for twenty-four to forty-eight hours. They receive no feed during this time. They are then put into the brooders and do not receive food until they are at least twenty-four hours old. Then start feeding them upon a mixture composed of about two-thirds rollod oats and one-third hard boiled eggs rubbed well together. This constitutes their principle feed for about ten days or two weeks. Gradually, however, some commercial chick feed is made to replace this rolled oat—egg mixture, until the chicks are practically entirely upon this commercial mixture. A small amount of fine meat scrap is also fed during this time. As soon as the chicks grow large enough to take wheat and cracked corn, this mixture is made to replace the commercial chick feed, and they are raised on this until time to be put in the laying pens. If it becomes desirable to force the pullets at any time, they are fed, once a day of the mash mixture similar to that given the laying hen.

METHOD VII. MYERS BROS., HAVRE DE GRACE, MD.

Our method of feeding chicks is according to appetite. They are given chick feed three times the first day. Water is before them at all times begining with the first feeding. No grit is given until they have outgrown the brooders and put on the range, as the brooder and house floor is covered with sand and gravel. From the second day until four weeks old they are fed chick feed, about 6.30 A. M. and 5 P. M., scattered in finely cut straw on pen or house floor. At 11.30 A. M. they are fed a dry mash (in troughs) composed of the following ingredients: wheat bran twenty per cent., wheat middlings ten per cent., corn meal twenty-five per cent., ground oats ten per cent., beef scrap twenty-five per cent., and bone meal ten per cent. About two per cent. of granulated charcoal is added to the above ration. We aim to feed about one-fifth more grain than mash. After the chicks are three weeks old the

beef scrap is gradually decreased, until at ten weeks old when the beef scrap is about twenty per cent. of the mixture. After the chicks are four weeks old the chick food is gradually changed for equal parts of cracked corn and wheat, and continue feeding the same proportion of grain to mash. At eight weeks old when chicks are weaned and put on the range, they are hopper fed; the hoppers contain equal parts of cracked corn and wheat, and the dry mash mixture that is fed to laying hens. (See Page 44.)

THE FEEDING OF LAYING HENS.

At the present time there are two general methods of feeding hens; they are commonly called wet and dry feeding. With the wet method some part of the daily ration is fed in a moist or crumbly condition; while with the latter method everything is fed in the dry or natural condition. For convenience these methods will be designated as the dry system and the wet system.

There are many successful users of both systems, which proves that the success of feeding depends as much on the man, as the kind or way in which the feed is given. For one who is about to start in the industry the dry system is recommended; mainly because there is less danger of under or over feeding; a great saving in labor, and the lessened danger of bowel trouble from sloppy mashes.

In the feeding of poultry a valuable lesson may be learned from nature. In the springtime the production of eggs on the farm is an easy matter. Fowls which are at liberty to roam find an abundance of green and animal food on their range, which with grain furnishes a perfect ration for laying hens. In addition to this they get plenty of exercise and fresh air. As far as possible the feeder should aim to make the winter conditions springlike. Fowls like humans do much better on a variety of foods, and care should be exercised not to feed too great a quantity of one food for any considerable length of time.

Whether the fowls are on free range or confined, see that they have an abundance of fresh water, oyster shells, grit and charcoal. Examine the feed and see that it is sweet and wholesome, as moldy feeds are poor producers of eggs. Keep the houses clean and dry during the winter months, as these two points have much to do with keeping the hens happy. If green food is neglected you must not expect a full egg basket at night. It is the little things that count on a successful poultry farm; and with good feed and proper attention there is no reason why a good living cannot be made from the business hen.

METHODS OF MARYLAND POULTRYMEN FOR FEEDING LAYING HENS.

The following methods were secured from successful men and women in different sections of the State.

METHOD I. DRY SYSTEM, MARYLAND EXPERIMENT STATION.

Grain Mixture.	Mash Mixture.
100 lbs. cr. corn.	100 lbs. bran.
100 lbs. wheat.	50 lbs. linseed meal.
100 lbs. oats.	50 lbs. corn meal.
	50 lbs. middlings.
	50 lbs. beef scrap.
	2 lbs. charcoal.
	2 lbs. salt.

For the morning feed each pen of forty fowls receives two quarts of the grain mixture well scattered in the litter. Betwen 8 and 9 o'clock from three to five lbs. of cabbage is given to every forty fowls. At noon the grain mixture is repeated the same as in the morning. This constituted all the feeding that is done by hand. The dry mash mixture grit and shell are kept in hoppers to which the fowls have free access at all times. This method of feeding has proven very satisfactory both as to egg production and general health of the fowls.

METHOD II. DRY SYSTEM, FREE RANGE, MR. J. CASSEL, WESTMINSTER, MD.

Grain.	Mash Mixture.
wheat screenings.	1 bushel wheat.
corn.	2 bushels bran.
	½ peck beef scrap.
	4 teaspoons of ginger and black pepper mixed to every bushel of mash.

In the morning the fowls receive a feed of wheat screenings well scattered in the litter, and alternating mornings cabbage and ear corn is hung up in the pen. A liberal feed of shelled corn is given at night. The dry mash mixture, beef scraps, grit and shell are kept in hoppers to which the fowls have free access at all times.

METHOD III. DRY SYSTEM, FREE RANGE, BELLE HILL, ELKTON, MD.

Grain Mixture.	Mash Mixture.
100 lbs. wheat.	100 lbs. model egg mash.
100 lbs. corn.	100 lbs. wheat bran.
100 lbs. barley.	200 lbs. beef scrap, charcoal and salt.
100 lbs. oats.	
100 lbs. buckwheat.	
100 lbs. Kaffir corn.	

The hens on this farm are kept in flocks of 1000 and both grain and mash is hopper fed. The fowls are always well supplied with grit, shell and charcoal. The green food is made by sprouting oats and allowing them to grow until they resemble a thick mat of green grass; this is kept before them most of the time. During the moulting season linseed and cottonseed meals are added to the mash, sunflower seed are also fed liberally.

METHOD IV. DRY SYSTEM, FREE RANGE, MT. PLEASANT FARM, HAVRE DE GRACE, MD.

Grain Mixture.	Mash Mixture.
½ bushel corn.	200 lbs. bran.
½ bushel wheat.	100 lbs. middlings.
	100 lbs. gluten meal.
	100 lbs. linseed meal.
	100 lbs. beef scrap.
	100 lbs. oat meal (when available).

The morning feed is the grain mixture scattered in the litter, about one quart to twenty fowls. At 9.30 mangels are given as a green food. The evening feed is given at 3.30 and consists of grain the same as in the morning. The mash mixture, grit, shell, charcoal and bone are kept in hoppers to which the fowls have free access at all times.

METHOD V. DRY SYSTEM, FREE RANGE, MYERS BROS., HAVRE DE GRACE, MD.

Grain Mixture.	Mash Mixture.
20 lbs. wheat.	100 lbs. bran.
40 lbs. corn.	100 lbs. middlings.
10 lbs. oats.	100 lbs. corn meal.
	100 lbs. beef scrap.
	8 lbs. charcoal.

Our system of feeding laying hens is to give half as much more of the grain mixture in the morning as at night. The amount of grain fed is regulated by the quantity of dry mash consumed; our aim being to feed twice as much grain as mash. The grain is fed in the litter or scattered broadcast in the runs in favorable weather. The dry mash mixture, grit, oyster shells and cracked bone are fed in hoppers to which the fowls have free access at all times. During the winter months they are fed about two per cent. more corn and two per cent. less of wheat. For green food we give (on alternate days) beets, cut clover hay or alfalfa; allowing about two pounds of beets and one pound of clover or alfalfa to every 100 hens. Beginning in August five per cent. of "Old Process Oil Meal," is added to the daily ration for the purpose of encouraging and hastening the molt.

METHOD VI. WET SYSTEM, CONFINED DURING WINTER, MR. MCGRAW, HAGERSTOWN, MD.

The morning feed is scattered in the litter after the fowls have gone to roost, and consists of three quarts of wheat for every 100 fowls. At 9.30 on alternate days one quart of millet seed, and one quart of hulled oats are well scattered in the litter. About 11 A. M. green bone is fed at the rate of half-ounce per bird., At 1 o'clock a moist mash of the following ingredients, is fed at the rate of four quarts to every hundred fowls. About eight quarts of cut clover hay is scalded, and to this is added twelve quarts of the mash mixture, mix thoroughly and feed in a crumbly condition.

Mash Mixture.

200 lbs.bran.
100 lbs. corn meal.
100 lbs. middlings.
100 lbs. gluten meal.
100 lbs. linseed meal.
100 lbs. beef scrap.

At 2.30 in afternoon every hundred fowls are given about six quarts of sprouted oats; this is fed as a green food. The evening meal consists of four quarts of corn, to which a little wheat is added in warm weather, for every hundred fowls.

METHOD VII. WET SYSTEM, FREE RANGE, FRIEDEL BROS., REISTERSTOWN, MD.

The morning feed consists of equal parts of wheat and buckwheat fed in the litter. At 10 o'clock they are given a feed of green bone and meat mixed, this is fed at the rate of one ounce to every hen. The green bone and meat is procured by buying old horses and cows, these are slaughtered on the farm, and the hide sold to help pay for the animal. Between three and four o'clock a moist mash of the following ingredients is fed; one bushel of small potatoes (cooked), twenty-five lbs. cracked corn, forty loaves of stale bread (which has been soaked for several hours) and enough bran added to the mass to make it crumbly. At night they receive all the corn they will eat.

METHOD VIII. WET SYSTEM, CONFINED DURING WINTER, MR. CHANEY, BURTONSVILLE, MD.

The morning feed is a moist mash, which is made by mixing bran and clabbered milk together; this is fed in a crumbly condition and allowing just what they will clean up in half an hour. At 10 o'clock steamed wheat is fed, giving all that they will eat; at noon the steamed wheat is repeated the same as at 10 o'clock. The night feed is corn or wheat, and care is exercised to see that there is none left over for morning. Beef scrap, grit, shell and charcoal are kept in hopppers to which the fowls have free access at all times. The process of steaming the wheat is quick and simple. It is placed in a large feed cooker and covered with water, a fire is then started and the whole allowed to steam for two or three hours; the grain is then very soft and quickly assimilated by the fowls.

Fig. 22—A view of outdoor brooders on a hillside, showing feed hoppers for young stock.

Fig. 23—An outdoor brooder at close range, showing watering can, and feed troughs.

METHOD IX. WET SYSTEM, CONFINED DURING WINTER, MR. GETTY, NEW WINDSOR, MD.

The morning feed consists of a moist mash which is composed of the following ingredients: ten pounds corn chop, ten pounds bran, and ten pounds of middlings; steamed alfalfa and meat scraps are added and the whole mixed thoroughly. The noon feed consists of five or six large sheaves of wheat for every hundred fowls. At night they are given all the corn they will eat. Turnips and pumpkins are fed as green food whenever available. Grit, shell and charcoal are kept in hoppers to which the fowls have free access at all times.

METHOD X. WET SYSTEM, FREE RANGE, MR. TAYLOR, BERLIN, MD.

For the morning feed four quarts of wheat, to every hundred fowls, is well scattered in the litter. The noon feed is a moist mash consisting of two parts by measure of bran, two corn meal, and one of middlings; these materials are thoroughly mixed with steamed clover hay and the whole fed in a crumbly condition. On alternate days soaked oats are substituted for the mash. For the night feed they are given all the corn they will eat. Beef scrap, charcoal, grit and shell are kept before them at all times.

MARKETING THE PRODUCTS.

A large part of the profit in poultry-keeping depends on the marketing of the products. The poultryman must be a good salesman as well as a good raiser of poultry. He must be a hustler and always on the lookout for better prices. He should produce a high grade product that somebody wants, and that most people will not take the trouble to supply. The man who makes the largest profit, is the one who receives from three to ten cents above market price, simply because a high-grade product put up in attractive packages is furnished with a guarantee on each package.

GRADING THE EGGS.

The eggs should be graded according to size and color; a dozen small eggs appear more attractive than a mixture of large and small eggs in the same package. Never mix different colored eggs. If eggs are received from outside sources, they should be carefully candled to insure freshness. Have all eggs spotlessly clean, dirty eggs may be fresh but they deceive their appearances.

MT. PLEASANT FARM

HAVRE DE GRACE MARYLAND

If the seal of this package is unbroken, I guarantee the eggs contained therein to have been laid on the date stamped on the seal. The eggs are warranted sterile, and to be the product of hens in perfect health, kept under the most sanitary conditions, and fed only sound, wholesome feed. Inspection of the farm is cordially invited, and trains will be met by appointment.

C. E. BRYAN, Proprietor.

Fig. 25.—An illustration of good business methods in marketing the products.

Fig. 26.—The Government guarantee of quality.

Fig. 27.—A corner of the shipping room on Mr. Taylor's farm, Berlin, Md.

DISPOSING OF THE PRODUCTS.

There are three general ways in which the poultry products may be marketed; (a) selling direct to the consumer, (b) selling direct to the retailer, (c) selling to commission merchants for sale on the open market.

SELLING DIRECT TO THE CONSUMER.

This is usually regarded as the most profitable method of disposing of high-grade goods, for all charges of the middleman are eliminated. The producer is often so situated that he can build up a retail trade among the families of a neighboring city or village; delivering his goods direct to the consumer, which often pays from three to ten cents above market price. This premium may make all the difference between small and large profits, as the cost of production remains the same regardless of the selling price. It is also often possible to secure customers in a city that is within reasonable shipping distance, expressing to them a regular amount of eggs and dressed poultry, once or twice a week.

Hotels, restaurants, clubs and hospitals are excellent customers, and very frequently they contract for their supplies in this way. As a rule such institutions are willing to pay good prices, and their trade is desirable because they require large quantities. You can readily see that it is cheaper and easier to ship to one customer, than to divide it among several who use small quantities.

SELLING DIRECT TO THE RETAILER.

There are many fancy grocery and provision dealers who cater to a select trade, that are glad of an opportunity to secure regular supplies of fresh eggs and poultry direct from the producer. These houses often pay a price that compares very favorably with that received from the customer, and under these conditions this trade is very desirable.

SELLING TO COMMISSION MERCHANTS.

The simplest method of disposing of all kinds of produce, is to consign it to commission firms for sale on the open market. This does away with the trouble and expense involved in working up a private trade; but the returns are usually not so great, except in certain instances where commission houses have built up a very high-class trade along certain lines.

Which of the above methods will pay best is a question for each producer to decide for himself. A great deal depends upon the market conditions, personal circumstances, and the kind of business done, whether on a small or large scale. The large majority of the farms visited were selling direct to the consumer. Several of the large exclusive poultry plants were shipping to New York, Boston, Philadelphia and Pittsburg. The New York market is generally from five to ten cents above the Baltimore and Washington markets, and where the express is paid by the receiving parties it would probably pay to ship to these markets.

PREPARING POULTRY FOR MARKET.

Anyone who will take the time to walk through the markets of large cities, will quickly realize that the bulk of the dressed poultry on the open market is received in very poor condition. People judge poultry by its appearance, and a choice young fowl that has been poorly prepared, often looks less attractive to the customer than an older or poorer fowl that has been carefully picked, plumped and packed for the market. The expense of killing, picking and packing poultry is small, and it is a pity to see good poultry that has been properly fattened, sell among the inferior grades because of careless handling.

DRY PICKING.

The success of dry picking depends largely on the manner in which the fowl is killed. There are two general methods of killing poultry for dry picking; First by sticking in the roof of the mouth, and secondly by breaking the neck; of the two methods the former is the most popular.

To be successful with either method requires practice, and if possible one should see the operation performed by a skillful picker.

When the fowl is to be stuck it is hung up by the feet, with a looped cord, so that it will bleed freely. Hold the head in the left hand, comb downward. Open the bill until you can see the slit in the roof of the mouth. Insert the small blade of a knife in the slit and thrust it backward toward a point directly back of the eye. As soon as the brain is hit the knife should be twisted half way round, and, as it is withdrawn should cut the arteries in the throat. When the brain is hit there will be a convulsive struggle or "squack," The stick will not be successful unless the convulsion or "squack" is produced. Picking should begin immediately with both hands, pulling the body feathers first, then the wing and tail feathers, holding the fowl with one hand and pulling with the other. As soon as the fowl is rough picked the pin feathering and finishing can be done more quickly in a sitting position; with the fowl on the lap and picking with both hands. Special care should be taken in pulling the feathers on the breast to avoid tearing. If the fowls are to be drawn it should be done immediately after picking. After being drawn they should be plunged in a tub of ice water, as this will contract the skin and give them a plump appearance.

SCALDING.

All fowls that are prepared for the Baltimore and Washington markets should be scalded as there is no demand on the open market for dry picked fowls. When birds are to be scalded before removing feathers they are immersed in hot water, which should be a trifle below the boiling point, as soon as they are through bleeding. The fowls should be immersed three or four times in order that the hot water may penetrate through the feathers to the skin. If the fowl is to be sold with head and feet on, care should be taken that these parts are not allowed to touch the water, as it will destroy the natural color. After picking the fowls they should be dipped in hot water for a few seconds, and then in cold water until they become throughly chilled. When chilled they are hung up in a cool place to dry, unless they are to be shipped some distance, in which case they should be packed with ice in layers separated by clean straw. In packing they should be laid in neat boxes side by side, backs downward, and the order reversed with each layer, so that they will be pressed in solid and retain their natural position.

PRESERVATION AND VALUE OF HEN MANURE.*

Hen manure and poultry manure in general are very rich in fertilizing constituents, especially nitrogen, due to the fact that, in addition to the undigested residue of the food it contains, the urinary secretions, in which are large amounts of nitrogen as well as potash in readily available form, are voided with the solid excrement in this class of animals. The analyses which have been made show that hen manure is very variable in composition, depending upon the stage of growth of the fowl, the character of the feed, and the care taken of the manure.

*Compiled from Farmers Bulletin No. 210.

The nitrogen has been found to vary from about 0.7 to 2 per cent., the phosphoric acid from 0.5 to 2 per cent., and the potash from 0.25 to 0.9 per cent. This shows that such manure if properly cared for is much richer than that of other farm animals. It, however, quickly loses nitrogen by fermentation and deteriorates in value if not properly mixed with absorbents or preservatives. Various methods of preventing this loss have been proposed.

The New York Station advises: "When the manure is not used when fresh, it is better to mix it with earth, muck or plaster." The Massachusetts State Station says: "The value of hen manure depends not less on the the care which is bestowed on its keeping than on the kind of food the fowls consume. A liberal use of plaster kieserite or of good loam is highly recommendable for the absorption of ammonia. A sandy soil is of little use as an absorbent."

The Maine Experiment Station reports comparative tests of kainit, plaster (gypsum), and acid phosphate singly and combined with sawdust as preservatives for hen manure. Three night's droppings of 180 mature, laying hens, amounted to about forty pounds, containing when fresh 2.8 per cent. of nitrogen, 1.8 per cent. of phosphoric acid, and 0.9 per cent. of potash, were mixed with various preservative materials and stored in barrels from May to November, 1903. An examination at the end of that time showed that from the dung stored by itself or with sawdust more than half of this had escaped during the summer. The lot stored with forty pounds of plaster lost about one third, while the lot stored with eighty-two pounds of plaster and fifteen pounds of sawdust suffered no loss. The lots with kainit and acid phosphate, both with and without sawdust, retained practically all of the nitrogen. Both because of the danger of loss and its tendency to form into hard lumps, the plaster is less desirable than either of the chemicals tried. The addition of the sawdust materially improved the mechanical condition of the lots so treated. A mixture of thirty pounds of hen manure, ten pounds sawdust, sixteen pounds of acid phosphate, and eight pounds of kainit would carry about 1.25 per cent. nitrogen, 4.5 per cent. phosphoric acid, and 2 per cent potash, which, used at the rate of two tons per acre, would furnish 50 pounds nitrogen, 185 pounds phosphoric acid, and 80 pounds potash.

COMMON DISEASES OF POULTRY.

By Geo. Edward Gage, Ph. D.

The success of poultrymen to bring their birds to maturity and make the business a success, depends upon the ability they possess to keep their flocks free from disease. Since it is the purpose of everyone engaged in the industry to produce birds capable of good egg and meat production, it must be the first duty of the poultryman to see to it that conditions are such that there is no chance for diseases to interfere with the good health of his flocks.

When we stop and think that there is probably no other class of livestock so subject to disease, as domestic fowls, it suggests that a knowledge of the diseases, their treatment and their prevention are essential to everyone engaged in the industry. From the shell to the fully mature bird, fowls are subject to a great variety of diseases, the most important of which will be taken up during this discussion.

Before mentioning any of the specific troubles which the poultryman is accustomed to encounter in every day practice it is necessary to emphasize strongly the importance which cleanliness plays towards success in poultry raising.

IMPORTANCE OF CLEANLINESS.

The lack of sanitary conditions about the poultry houses and yards are a great factor in the transmission of diseases. The location of the poultry plant and its drainage are to be considered, for dampness in the houses and mud in the yards are most unfavorable conditions for poultry raising. The proper amount of space and ventilation in the houses should be carefully considered. Cleanliness is an essential sanitary condition for birds, accumulations of excrement laying about the houses are the means for the transmission of the most deadly diseases. These excrements when in a moist condition in a warm house harbor the parasites and bacteria which may be the means of annihilating large numbers of poultry. A few suggestions will not be out of place here as regards making the conditions sanitary for birds. The droppings boards should be cleaned at least once a week and if possible every morning. A small quantity of road dust or land plaster should be sprinkled about. These materials will absorb the moisture and bad odors and also add to the value of the droppings. The nests should be cleansed once a month and the old nesting material replaced with fresh new straw. The addition of a little lime or insect powder will help in eradicating lice and mites. A great factor in establishing sanitary conditions is the application of whitewash. There is no material more purifying than good hot whitewash. This may be made more effective by the addition of four ounces of carbolic acid per gallon. The yards may be kept clean and sweet by cultivation and seeding. Attention to these little things may save flocks from many a troublesome disease.

The diseases which are to be considered in a general way are those which have caused the most trouble among poultrymen namely, white diarrhœa, gapes, roup, pip, bumble-foot, cholera, intestinal worms, scaly legs, diarrhœa, etc. Concerning many of the diseases there is little definite knowledge. A short review of what has been done will be of benefit to the readers.

WHITE DIARRHOEA.

Diarrhœa is caused by some irritation of the digestive system. According to Dr. Morse of the Bureau of Animal Industry, U. S. Dept. of Agriculture, white diarrhœa is caused by an animal parasite being

harbored in the intestinal tract of the bird. The parasite is called by him Coccidium tenellum. The disease claims as its victims mostly chicks between two and five weeks of age. The symptoms are dullness and general weakness, accompanied by a white pasty, fecal discharge. White diarrhœa may be better spoken of as a symptom rather than a disease, for it is an outward sign of some internal diseased condition; which may have the Coccidium tennellum of Morse, or a certain bacterium known as Bacillus pullorum gallinarum as the specific agent causing the trouble. This last mentioned organism was discovered by Professor Leo F. Rettger, of Yale University, and it has been found to give rise to the white diarrhœal discharges and cause great mortality among young chicks.

POINTS TO BE CONSIDERED IN THE PREVENTION OF THE DISEASE.

The treatment for white diarrhœa among young chicks is an almost hopeless task. The treatment is one of prevention and this must begin with the eggs used for hatching. These should be thoroughly and antiseptically cleansed by wiping in 95 per cent alcohol. If artificial incubation is used (and in this method lies the great hope of success) the incubator, if used before, should previous to receiving the eggs, be carefully washed with antiseptic solutions and exposed to the sun. The egg tray should be scalded or flamed, and the floor should be movable so that it may be removed and sterilized, and if made of burlap, the old piece should be torn off and a new one mounted on the sterilized frame. The same precautions should be used with the brooders. The sun has a great disinfectant action and if poultrymen will see to it that the soil to which the chicks have access is well sprinkled with lime, dug up, and exposed to this natural disinfectant agent there would be less trouble from disease. However, with all the foregoing precautions absolute freedom from the disease cannot be granted without further experimentation.

GAPES.

Gapes sometimes destroy large numbers of small chickens, in fact, on some farms during certain seasons it seems almost impossible to rear broods of young chicks that are entirely free from it. Gapes is a parasitic disease caused by small worms known as *Syngamus trachealis*. The disease may be readily detected by the obstructed breathing and consequently frequent gaping, a characteristic from which the disease takes it name.

TREATMENT.

Healthy chicks should be prevented from becoming contaminated by removing them to clean quarters and clean thoroughly the coops, pens and houses. The little chickens should be kept in a dry place and away from any ground which has been previously infected. Disinfection is the best measure to follow out in the treatment of gapes. The drinking troughs should be carefully disinfected with a five per cent.

solution of crude carbolic acid or with boiling water. The careful poultryman will see to it that the bodies of the birds which die are burned and keep the infected birds in houses that can be easily disinfected and makes sure that this is thoroughly done.

By careful manipulation the worms may often be removed and the chickens quickly cured in this way. To accomplish this either a feather or a horse hair may be used. If a feather is selected, it is stripped of the web except near the tip. This may be used dry or it may be moistened with coal oil. If a horse hair is employed it is folded and the two ends twisted together so as to leave a small loop at the folded extremity. To extract the worms the chicken's mouth is forced open and the hair or feather is thrust into the opening and downward into the trachea. It is then turned or twisted around several times and withdrawn, when one or more worms may be found adhering to it or in other cases are coughed up, having been loosened by the feather or hair. These worms should be destroyed, as they are capable of spreading the infection. By dusting some air-slaked lime into the infected broods in a barrel or comparatively tight box; the chickens will be required to breathe the air heavily laden with this fine lime, which will cause the dislodgment of many of the worms. This treatment is rather severe, and may be rather harsh for the weaker birds, yet it will be a great help in saving the larger proportion of a brood which otherwise might die.

ROUP.

Roup is considered contagious by eminent authorities. Without doubt unsanitary conditions are a powerful factor in the transmission of the disease after it is once started. The symptoms of the disease are very noticeable. Among the first to be observed is the thin watery discharge followed by obstructed breathing. These cases may be readily detected by passing through the houses at night.

Dr. G. E. Salmon claims that the inflammation extends, as the disease advances, from the membrane of the nasal cavaties to those of other connecting passages. The spaces surrounding the eye connects with the nasal passage consequently this becomes inflamed and a bird in such a condition presents a most miserable appearance. Sometimes the inflammation is so far advanced that the bird is completely blinded.

In the later stages of the disease the false membrane obstructs the nasal passages, presses down the palate, and may prevent swallowing. The specific agent which causes roup is not definitely known. Dr. Hadley of the Rhode Island Experiment Station, in a recent contribution claims that in several cases of the disease, he found parasites (coccidia) present on all the mucous membranes in sufficient numbers and stages to produce nearly all the diseased conditions. Just as Morse claimed that white diarrhœa is caused by a Coccidium tenellum in the digestive organs, and blackhead is a coccidiosis of a special part of the intestines and the liver in turkeys, so this writer believes that many and perhaps all cases of the disease popularly called "roup" are instances of an infection by these parasites of the mucous membranes of the head region with or without intestinal complication.

Here again, as with most of the diseases, the measures to be followed out is one of prevention. Healthy birds should be removed to clean quarters. Antiseptic solutions are to be injected into the nostrils and the roof of the mouth. The pus like or cheesy deposits should be removed and the cavities carefully washed with antiseptic solutions. The following solutions have been recommended by several writers:

1. Two per cent. solution of creoline.
2. Two per cent. solution of carbolic acid.
3. Peroxide of Hydrogen and water, equal parts.
4. One grain permanganate of potash to an ounce of water.
5. Kerosene oil mixed with equal parts of lard or olive oil.

White spots usually accompany the development of diptheritic roup seen scattered about on the roof of the mouth and on the connecting air passages. Dr. Salmon recommends that a two per cent. solution of creoline be applied to the diptheritic spots in the mouth and eyes. Tincture of iodine has been applied to the diseased parts successfully. Boric acid, fifteen grains to an ounce of water, may be applied to the mouth, nostrils and eyes.

Everything about the poultry houses should be thoroughly disinfected. The feeding troughs should be washed with a solution of carbolic acid, one and two-third ounces of carbolic acid to one quart of water. The following taken from Watson's Farm Poultry may be mixed with the food several hours before feeding as a curative and a preventive agent. A pinch of the following mixture for each fowl.

Hyposulphite of soda	50 grams.
Salicylate of soda	50 grams.
Pulverized ginger	200 grams.
Pulverized yellow gentian	200 grams.
Pulverized sulphate of iron	100 grams.

Sulphate of iron should be given in the drinking water, 1½ grains to a quart of water.

PIP.

"Pip" is a term used by poultrymen to express a condition of inflammation of the mucous membrane of the mouth and often made to cover a large part of the diseases to which birds are subject. Using it to mean the inflammation of the mucous membrane of the mouth it may be said that the disease may arise from any local irritation or injury which is of long enough duration to set up inflammatory action It may under certain conditions be caused by microorganisms of feeble virulence when the general system is deranged such as poor digestion and abnormal circulation. In most of the other cases it is due primarily to drying of the membrane caused by breathing through the mouth because of the diseased condition in the respiratory passages.

The common treatment for so-called "pip," when there is simple drying of the mouth is to moisten the tongue with a few drops of a mixture of equal parts of glycerine and water. When the membrane

is red an excellent remedy is made by dissolving fifteen grains of boric acid in an ounce of water, and applying this to the affected parts. If properly treated this disease remains localized and is of slight importance.

BUMBLE FOOT.

Bumble foot has been reported as one of the troublesome ailments of poultry. It is caused by bruises on the bottom of the feet. These bruises very often swell and are filled with pus, and if not lanced and the pus allowed to escape, the lesion becomes cheesy and forms into a hard lump, which may become a permanent enlargement. Any material which will induce free formation of pus is a good remedial agent. Poultices are excellent preparation to apply locally.

SCALY LEGS.

In this disease the upper layer of scales become loosened on the surface and elevated by the formation of a white crust or powdery substance beneath them. This is what gives the legs a rough and enlarged appearance. The disease progresses rapidly and extends along the toes until the whole shank and foot become involved.

This disease is caused by a mite known as *Sarcoptes mutans.* It is strictly a contagious disease, although it does not spread rapidly among the flocks. It attacks quite a variety of birds, fowls, turkeys, pheasants, partridges and cage birds, but has not been observed in ducks and geese.

The mite penetrates beneath the surface scales and by burrowing there sets up an irritation which leads to a multiplication of the cells which cause the serum to exude. When this serous exudate and the cells unite, the white powdery crust is formed which raises the surface scales from their normal position. Beneath this crust may be seen by the use of a microscope the male and female larvæ of the mite, Sarcoptes mutans.

TREATMENT.

The affected birds should be isolated to prevent the spread of contagion. The houses should be thoroughly cleansed. Carbolated lime wash should be applied. The scabs should be removed from the legs and affected parts by soaking for some time in warm water to which a little soap has been added. Having removed the scales sufficiently the legs should be dried and carbolic ointment (1-10) applied. The disease if taken at the right time is not difficult to cure, if care is exercised in the first treatment and all the scales and crust are removed.

FOWL CHOLERA.

This is a contagious disease of birds caused by bacteria and transmissable from bird to bird by living together and inoculation. It attacks all varieties of domestic poultry such as chickens, ducks, geese, pigeons, turkeys also parrots and canaries.

Infection generally occurs by taking food or drink contaminated with the excrement of birds suffering from the disease. Birds may be infected through wounds in the skin or by inhaling the bacteria suspended as they may be in the air.

SYMPTOMS.

Birds usually stop eating or the appetite lessens as the disease comes upon them. Perhaps the earliest indication of the disease is a yellowish coloration of the urates or that part of the excrement which is secreted by the kidneys. Usually this material is white in color, although according to Dr. Salmon's description of the symptoms, this yellowish color of the material secreted by the kidneys is not an absolute certain proof of cholera. However, it is a valuable indication when the disease has appeared in a flock and an effort may be made to check its course by isolating the sick birds as soon as possible.

Diarrhœa is a prominent symptom, the discharges being made up of yellowish material suspended in a thin, transparent, frothy mucus. Diseased birds rapidly lose in weight and they become so weak that a slight touch will cause them to fall over. This disease may rapidly run through a flock. destroy the greater part of the birds in a week, or it may assume a more chronic form and extend slowly and remain about the poultry yards for weeks, or even months.

APPEARANCES AFTER DEATH.

The comb is pale and bloodless, the liver in nearly all cases enormously enlarged, and the gall-bladder is distended with thick dark bile. The crop is generally drawn out of shape, and the stomach when viewed from without present circular discolorations which are found to be small clots of blood outside the blood vessels. The blood vessels are sometimes filled with a firm clot and contain but little liquid.

TREATMENT.

The drugs most frequently used are sulphur, copperas, capsicum, alum and resin, but after a careful survey of the literature on the subject it is deemed wise not to put too much confidence in internal treatment. Sanitary measures are the ones to be strictly observed to eradicate cholera. Since the disease is transmitted by germs it is necessary by disinfection to eleminate them from the roosts and poultry houses. Disinfection should be constant while the disease is about the premises. Carbolic acid, one pound to twelve quarts of hot water or sulphuric acid one pound to fifty quarts of water. The sulphuric acid should always be mixed by pouring the acid into the water. A wooden pail is best adapted for this, since it will not corrode. If carefully used with proper precautions sulphuric acid is the most satisfactory disinfectant. Great care should be used in employing this method.

METHODS OF DISINFECTION.

When birds have contracted the disease they should be moved to new runs and new houses. The floor should be saturated with the dilute sulphuric acid. A convenient method for an application is to pour the disinfectant solution in a watering can, and sprinkle it about. The droppings should be swept up, disinfected and removed every day. The building should be whitewashed and the disinfecting effect be increased by adding one-quarter of a pound of carbolic acid to each gallon of lime.

When an outbreak of cholera has been noted it may be decided to kill the sick in order to get rid of the contagion as rapidly as possible. If such is the case a deep hole should be dug, the birds put in it and killed there so that their bodies and blood will be buried together. In any case birds dying from the disease should be burned or deeply buried.

INTESTIONAL WORMS.

The parasitic worms of the intestinal tract may be grouped as tapeworms, flukes, roundworms and thorn headed worms.

The symptoms that would indicate the presence of worms in the intestines are not characteristic. The birds usually become dull, weak, emaciated, isolate themselves and show signs of diarrhœa. In certain cases the symptoms develop rapidly. According to Nessl, young fowls which harbor numerous tape worms lose their appetite, become dull and feeble, isolate themselves, and hold their head under their wings. The only certain sign is the presence of sections of the tapeworm in the excrement. These worms may be found by the thousands.

The round worms of the class known as Heterakis often exist in enormous numbers in the intestinal tract of pigeons and may be so prevalent in certain localities that it will prevent the raising of these birds. Round worms are often found in the intestinal tract of our domestic fowls.

TREATMENT.

Hygienic measures should be resorted to in cases of infestation of the digestive tract by parasitic worms. The fowls should be moved to fresh ground every two to three years. The excrements should be removed from the houses and any parasites or their eggs destroyed which may be in them, by mixing with quick lime or saturating them with a ten per cent. solution of sulphuric acid. When treating diseased birds these should always be isolated and confined, and their droppings burned or treated with lime and sulphuric acid.

The following methods have been recommended by Dr. Salmon for the treatment of tape worms:

1. Mix in the feed a teaspoonful of powder pomegranate root bark for every fifty head of birds.

2. Zurn recommended that areca nut in doses of thirty to forty grains mixed with butter and made into pills be administered.

3. Oil of turpentine is an excellent remedy for all worms which inhabit the digestive canal. Dose one to three teaspoonfulls.

Megnin recommends mixing santonin with the food for the treatment of heterakis or round worms. Intermittent doses of calomel have been successfully used in doses of one-sixth to one-third grains. The feeding of peas mashed up in a cold decoction of wormwood is said to be effective. No treatment is given for fowls affected with trematodes or flukes, as these parasites as far as known do not affect the health of the birds which they infest.

With the foregoing general discussion of our common poultry diseases, the poultryman will surely see the precautions and necessary care that must be taken of his yards and houses, if he is to keep his flocks free from disease and insure himself of success in the industry.

THE POSSIBILITIES.

That there is room for great development in the poultry industry in this State, as in other states, is clearly proven by the fact, that twenty years ago a man who kept 500 hens was a curiosity; while today there are ranches that carry from 5000 to 8000 laying hens, and are making a financial success of the industry. It is also a fact that a few years ago broilers, squab broilers, roasters, winter chickens and capons were strange words because seldom used, today they are common expressions. Tons upon tons of high-grade poultry meat is consumed daily, and we might say that we are just starting. This is but the result of a quarter of a century, and the demand for high-grade products far exceeds the supply of the present day.

The soil and climate of Maryland for the most part are well adapted to successful poultry raising. The winter months are comparatively mild, which allows the fowls to enjoy free range for the greater part of the year. The Eastern Shore of the State on account of its numerous rivers and streams, furnishes an ideal location for the raising of ducks, geese and other water fowls. The greatest drawback to this branch of the industry are the terrapin, which are very destructive to young water fowls.

MARKET.

It is true that the market price of eggs is lower in Baltimore and Washington, than in New York, Boston or Philadelphia. This is probably due to the fact, that it is less difficult to produce eggs during the winter months; and to the lack of congested areas of population. With the present railroad facilities there is no reason why Maryland farmers who wish to take advantage of these higher prices, cannot do so without encountering any serious difficulties. As a matter of fact there are several large poultry farms in Maryland that are shipping the bulk of their product to these northern markets and thereby securing the additional profit over the home market.

FAILURE.

In conversation with the owners and managers of large poultry farms, developed the fact that the hens were very little more than paying expenses. The extremely high price of grains, the difficulty of securing and retaining competent labor, and in many instances the amount of money invested and the lack of experience have helped to bring about this condition. People should not be discouraged by such statements. Consider for a moment the vast number of abandoned farms in our eastern and southern states; and you will realize that the failures in the poultry industry are not as numerous as those of general farming.

Do not be discouraged by the failures of others. There are many who are making a success, and that success is due to a careful study of the industry, observations, hard work and good business ability. To those who are willing to proceed slowly and carefully study every detail of the industry, there is no branch of agriculture that offers greater inducements than the poultry business of the present day.

SUCCESS.

It is difficult to get actual figures from poultrymen. Very few of them keep any record of egg yield or of food cost, but Mr. Chaney, of Montgomery County, has given me a record of the egg yield and the prices received, and I quote his statement to show what has actually been accomplished in this State in practical poultry keeping. These reports include the number of hens for each year, the monthly egg yield, and the prices received each month for several years.

1905—376 Hens.	Dozens of Eggs laid.	Amount received.
January	181½	$ 65.02
February	285	101.12
March	461½	103.05
April	514	108.70
May	643½	131.39
June	457	93.20
July	383	79.65
August	449½	106.54
September	326½	91.24
October	246	75.49
November	109½	38.15
December	159	55.65
Stock sold		33.14
124 added to flock		62.00
Total	4216	$1144.34

Average price of eggs per dozen 24¾ cents.
Average return per hen $3.04.

1906—500 Hens.	Dozens of Eggs laid.	Amount received.
January	320½	$ 96.98
February	234	63.76
March	704½	130.54
April	702½	146.09
May	799	169.57
June	563½	125.78
July	646	148.34
August	411½	103.85
September	335	100.59
October	270¾	89.20
November	78	31.00
December	91½	35.50
Stock sold		165.94
62 added to flock		31.00
Total	5156¾	$1438.14

Average price of eggs per dozen 24 1-5 cents.
*Average return per hen $2.87.

1907—562 Hens,	Dozens of Eggs laid.	Amount received.
January	386	$ 128.43
February	355½	141.30
March	444	115.27
April	705½	147.04
May	548	106.90
June	560	118.73
July	630½	139.00
August	382	95.79
September	335	102.16
October	193½	72.32
November	256	106.24
December	323	134.62
Stock sold		287.33
188 added to flock		94.00
Total	5119	$1789.13

Average price of eggs per dozen 27 1-3 cents.
Average return per hen $3.18.

*NOTE—In giving the average return per hen, the cost of food was not deducted. Mr. Chaney estimates the cost of feeding a hen at $1.00 a year.

1908—750 Hens.	Dozens of Eggs laid.	Amount received.
January	658¾	$ 197.67
February	530½	163.54
March	865½	184.32
April	1217	223.90
May	984½	186.81
June	963	185.65
July	854¼	194.18
August	638	164.91
September	541¾	175.91
October	126¼	46.48
November	112	45.75
December	398½	162.05
Stock sold		376.46
100 added to flock		50.00
Total	7890	$2357.53

Average price of eggs per dozen 24½ cents.
Average return per hen $3.04.

One has but to glance at the summary of each year's report to see what a handsome profit Mr. Chaney is realizing from his poultry. His methods of feeding are simple and practical and are described on page 45. The eggs and poultry are sold in Baltimore, where he is able to secure from three to five cents above the market price for strictly fresh eggs. Mr. Chaney's success is the result of observations, good business ability and a willingness to proceed slowly. His first flock of fowls could be expressed in two figures and he has gradually increased, until today he has 800 White Leghorn hens that are paying him a net profit of from $1000 to $1200 a year.

At the Maryland Experiment Station, six pens of White Leghorns showed the following profit for one year.

Pen No.	No. of fowls.	Income.	Feed.	Profit.
1	40	$ 96.68	$41.88	$54.80
2	40	101.25	43.14	58.10
3	40	103.37	44.22	59.13
4	40	106.02	43.96	62.05
5	40	93.13	42.82	50.30
6	40	94.73	42.76	51.95

These facts and figures which are absolutely correct, should convince the most skeptical, that with proper care and management a good living can be made from poultry.

FOOD COST.

On farms that grow grain and where there is much waste grain that the chickens eat, the cost of feeding a hen for one year would probably not exceed seventy-five cents; but where all the feed has to be purchased and paid for at market prices, the cost will vary from $1.00 to $1.50 per fowl. The cost of raising pullets will usually be offset by the price received for the hens when they are marketed. If properly cared for and fattened the surplus cockrels should be marketed at a profit.

LABOR COST.

On the general farm where from 50 to 300 laying hens are kept the labor item is practically nothing; but on large poultry plants it is an important item, and if care is not exercised the cost of labor will eat up the profit of the business. The work must be systematized so that one man can successfully care for a large number of fowls. On one large farm which was visited, two men were caring for 4000 fowls; on another, one man was caring for 2500. A minimum number for one man would be about 1000. Mr. Chaney who keeps about 800 fowls is realizing a profit of about 1200 dollars a year, which is considerable more than many men are supporting large families with. This would naturally show us that it is more economical to keep about 1000 hens and perform the necessary labor yourself; rather than keep a larger number and be compelled to hire outside labor which is often very unsatisfactory.

THE PROFITS OF MIXED POULTRY.

There is no doubt but that the greatest profit is made where poultry is kept as an adjunct to the other farm crops. On the general farm the feed item and the labor item, as well as the item of land, are of smaller account than on larger poultry farms. To the farmer who is willing to give as much attention to the poultry as he does to any other part of the farm operations, there is a good profit to be made with very little expenditure of time and money. Mr. Chaney's reports should convince one that this statement is true, and what he has accomplished may be duplicated by every man who is willing to make the effort.

Wherever it is possible the colony house system is strongly recommended for the general farm. It has the advantage of being able to move the poultry to any part of the farm, and many times a corn or stubble field for the fowls to range over would mean a great saving in the feed bill. The droppings would also help to fertilize the land as they are richer than that of any of the domestic animals. Poultry kept in this way and receiving the proper attention, should soon prove to be one of the best paying branches of the farm.

POULTRY LITERATURE.

Farmers Bulletins of the United States Department of Agriculture.

The following bulletins are for free distribution and copies will be sent to any address on application to any Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C.

No. 41. Fowls: Care and Feeding.
No. 51. Standard Varieties of Chickens.
No. 64. Ducks and Geese.
No. 128. Eggs and Their Uses as Food.
No. 141. Poultry Raising on the Farm.
No. 177. Squab Raising.
No. 182. Poultry as Food.
No. 200. Turkeys.
No. 236. Incubators and Incubation.
No. 287. Poultry Management.

The following bulletins contain short articles on the subject mentioned, while those above are entirely devoted to poultry.

Raising Geese for Profit—No. 65.
Feeding Poultry—Nos. 84, 97, 107, 144, 186.
Preserving Eggs—Nos. 103, 273, 296.
Dressing and Packing Poultry—No. 144.
Selling Eggs by Weight—No. 114.
Early Moulting of Hens—No. 186.
Cost of Eggs in Winter—No. 190.
Poultry Appliances—Nos. 316, 317.
Fertility of Eggs——No. 251.
Incubation—Nos. 281, 309.
Cause of Death of Young Chicks—No. 309.
Healthy Poultry—No. 305.
Snow for Poultry—No. 309.
Digestibility of Fish and Poultry—No. 276.
Guinea Fowl—No. 262.

The bulletins of the Bureau of Animal Industry, United States Department of Agriculture; treating on poultry topics, may be purchased of the Superintendent of Documents, Union Building, Washington, D. C. A circular giving titles, prices, etc., may be had upon application to the above address.

POULTRY BOOKS.

American Standard of Perfection.........Cloth $1.50 Leather $2.00
Artificial Incubation and Brooding.........................$ .50
Broilers and Roasters—J. H. Robinson..................... .50
Chick Book .... .50
Diseases of Poultry—Salmon .... .50

Diseases of Pigeons—J. A. Summers	.50
Duck Culture—Rankin	.50
Ducks and Geese	.75
Farm Poultry—Watson	1.25
First Lesson in Poultry Keeping—Robinson	.50
How We Make Ducks Pay—Weber Bros.	.50
New Book of Poultry—Louis Wright	8.00
Poultry Craft—J. H. Robinson	1.50
Poultry Plant Construction—Cyphers	1.00
Poultry Culture—I. K. Telch	.50
Poultry Feeding and Fattening—Fiske	.50
Profitable Egg Farming	.50
Profitable Market Poultry	.50
Profitable Poultry Houses and Appliances	.50
Profitable Poultry Keeping in all its Branches	.50
Profitable Care and Management of Poultry	.50
Profits in Poultry	1.00
Progressive Poultry Culture—Brigham	1.50
Reliable Poultry Remedies	.25
Turkeys and How To Grow Them	1.00
Turkeys Care and Management	.50

All the above books may be obtained, at the price quoted, from the "Cornell University Poultry Association," Ithaca, New York. Orange Judd Publishing Co., New York City, or from any book store.

QUESTIONS AND ANSWERS.

The following questions were taken from numerous letters which have been received at this office:

Q. 1. What type of poultry house is best adapted to Maryland's climate?

Ans. 1. The open or cloth front house as described on page 24. This is the general plan, that is recommended in the construction of both large and small houses.

Q. 2. Do you consider the hooded roost necessary?

Ans. 2. This is a question that is being investigated by this Station at the present time, the results of which will be published in the near future; and until some definite conclusions are reached the reader will have to use his own judgment as to what he considers best.

Q. 3. What is the best floor for a poultry house?

Ans. 3. The floor may be of earth, wood or cement. It is important that the floor be dry, otherwise it will be impossible to keep the litter on the floor fit for use. Earth floors should only be used where there is a good natural drainage, otherwise they will soon become damp and filthy. The great objection to the earth floor is the difficulty of keeping them clean, for it is usually necessary to remove several inches of the top and to replace this with fresh soil, and even then one cannot be certain that all the droppings have been removed.

Board floors, unless constructed from good material and raised from the ground, will rot out in a few years. By raising the floor about eight or ten inches from the ground, which will allow a circulation of air under the buildings, will add greatly to the life of the floor.

For general purposes there is nothing better or more economical than a good cement floor. It is very easy to keep clean, and is dry and rat proof which are very important points where poultry is kept.

Q. 4. How many nests should be provided for 100 hens?

Ans. 4. A general rule is to allow one nest to every five hens.

Q. 5. What is a good disinfectant for poultry houses?

Ans. 5. The reader is referred to "Farmers' Bulletin" No. 345, issued by the U. S. Department of Agriculture. This report is free to every citizen of the United States and thoroughly covers the question of disinfectants. Also see page 59 of this bulletin.

Q. 6. Is a dust bath essential?

Ans. 6. Where fowls have free range it is not important; but when confined to houses or small yards a dust bath should be provided.. It is a great help in keeping down the lice, and where fowls have a good natural dusting place, the plumage seems to be smoother and brighter.

Q. 7. How many square feet should be allowed for each bird?

Ans. 7. Where the fowls are confined during the winter months, an allowance of at least four square feet should be made for each bird; but where the fowls are on free range the amount of floor space is not so important, a minimum allowance would be about two square feet per fowl.

Q. 8. What incubator do your consider the best?

Ans. 8. It is impossible to say what make of incubator is the best, but on page 29 is given the names of the machines that have proven satisfactory to poultrymen in Maryland.

Q. 9. Is moisture necessary for successful incubation?

Ans. 9. Yes, but owing to the lack of definite data, it is impossible to say, how or in what quantities it should be supplied. (See page 28).

Q. 10. How often should the eggs in the incuabtor be turned and cooled?

Ans. 10. The eggs should not be turned or cooled until the third day, after which they should be turned and cooled twice daily until the eighteenth day. The incubator should not be opened after the eighteen day, (see page 30).

Q. 11. Should eggs kept for hatching purposes be turned daily?

Ans. 11. There is a difference of opinion on this question, but it is advisable that where eggs are kept for a week or more, that they be turned at least twice a week.

Q. 12. How long should the chicks remain in the incubator after the hatch is complete?

Ans. 12. It is well to leave the chicks in the incuabtor from twenty-four to thirty-six hours, they are then strong on their legs and able to take care of themselves.

Q. 13. At what temperature should the incubator be operated?

Ans. 13. The average temperature for operating an incubator is between 102½ and 103 degrees F. For best results you should follow the directions that come with the incubator.

Q. 14. Is there any truth in the theory that the shape of the egg controls the sex?

Ans. 14. The results of tests do not support this theory.

Q. 15. At which temperature should the brooder be operated?

Ans. 15. For the first week the temperature of the house should be between 95 degrees and 100 degrees F., and if the weather is not severe a decrease of 5 degrees each week should give good results, (see page 35).

Q. 16. What foods would you advise for the feeding of little chicks?

Ans. 16. See page 39.

Q. 17. What is meant by the term "dry mash?"

Ans. 17. The term "dry mash" is used when speaking of a mixture of ground foods that are fed in a dry or natural condition.

Q. 18. Please give me a good ration for laying hens?

Ans. 18. See page 42.

Q. 19. What do you consider a good green food for winter months?

Ans. 19. The following green foods have proven practical for winter feeding; cabbage, clover, alfalfa, mangels, sprouted oats, turnips and pumpkins.

Q. 20. What is a good ration for fattening surplus cockrels?

Ans. 20. A good ration for fattening surplus cockrels is made of six parts by weight of corn-meal, two middlings, one-half part linseed meal and two beef scrap. This is mixed with skim milk or tepid water and fed three times a day. It should be made thick enough so that it will drop and not run, from the end of a wooden spoon. Give all they will eat in half an hour., the troughs are then removed and cleaned.

Q. 21. Which breed do you consider the best for egg production?

Ans. 21. This question is asked by a great many people and is rather a difficult one to answer. The White Leghorns are considered by many breeders to be the best all around fowls for egg production; but as a matter of fact many people are able to secure better results from some of the other breeds, due partly to the fact, that they are partial to that particular breed. It must be borne in mind that there are many strains of every breed, and that some breeders have the production of exhibition stock as their main object, while others have the egg production. One can readily see that where several breeders are striving to attain their ideal, we may have in one case a strain of Leghorns that are heavy egg producers or are poor producers on account of being bred for the show room.

Q. 22. Would you advise the use of the trap nest?

Ans. 22. Where the production of registered stock is a specialty, the trap nest must be resorted to, but on the average farm the egg production may be increased, by selecting the earliest producing pullets and using them for breeders the following year. The trap nest has shown, that the pullets which begin to lay at an early age as a rule develop into heavy layers.

Q. 23. How many hens should be kept in one flock?

Ans. 23. For the average person it would not be advisable to keep more than 100 hens to a flock, but there are many successful men who keep from 200 to 1000 in a single flock.

Q. 24. At what age should the sexes be separated?

Ans. 24. As a general rule the sexes are separated when the chicks are taken from the brooder and put on free range. They are then from eight to ten weeks old and the cockrels are sufficiently developed to easily distinguished them from the pullets.

Q. 25. Is it advisable to keep hens longer than two years?

Ans. 25. From the production standpoint it is not considered profitable to keep a hen after her second year; but if the hen is valuable as a breeder she is often kept for several years.

Q. 26. How many hens should be allowed to one male?

Ans. 26. For the light active breeds, such as the Leghorns and Minorcas, one male will be sufficient for a pen of twenty females. In the case of the medium sized fowls, such as Plymouth Rocks and Wyandottes, one male should be provided for every ten or twelve females. With heaviest breeds like the Brahmas and Cochins, one male should not be mated with more than ten females.

Q. 27. Do you know of any method that will prevent hens from eating eggs?

Ans. 27. The habit of egg eating may be caused by the lack of proper foods, broken or frozen eggs and various other reasons. In many instances it may be overcome by supplying plenty of lime in the form of oyster shells, bone or similar substances to insure a firm shell. See that the nests are well supplied with straw and have them darkened, so in case the egg is accidently broken the fowls will not be likely to discover it.

Q. 28. At what age should a cockrel be caponized?

Ans. 28. For the best results the caponizing should be done when the cockrels are from eight to ten weeks old or when they weigh about two pounds, depending largely on the development.

Q. 29. What is a good formula for making whitewash?

Ans. 29. The receipt for making what is commonly known as 'Government" whitewash for both indoor and outdoor work is as follows: Half a bushel of unslacked lime; slake with warm water, covering it during the process to keep the steam; strain the liquid through a fine sieve or strainer add a peck of salt, previously well dissolved in warm water; three prounds of ground rice, boiled to a thin paste and stirred in boiling hot; half a pound of Spanish whiting and a pound of

glue that has been previously dissolved over a slow fire; add five gallons of hot water to the mixture, stir well, and let it stand a few days, covering up from the dirt. It should be put on hot.

Q. 30. What is a good method of preserving eggs for home consumption?

Ans. 30. Before giving any methods of preserving, it will be well to mention that eggs intended for this purpose should be absolutely fresh and clean, and secured from hens that have no males running with them. A very good preservative may be made by boiling ten quarts of water, and after it has cooled add one quart of water-glass (sodium silicate). The solution should be placed in a jar or other suitable vessel, and the fresh eggs added from time to time until the jar is full; but be sure that there is two inches of solution covering the eggs. Do not wash eggs before packing, as it injures the keeping qualities by dissolving the mucilaginous coating.

Eggs may also be preserved in dry salt. There should be at least two inches of salt above the upper layer of eggs.

The following pickle is very good and can be prepared at home:

3 gallons of water.
1 pk unslacked lime.
1 pk coarse salt.

The water should be heated to 212 degrees F., or to the boiling point; part of the water should then be used to slack the lime, after which the remainder of the water is added; the salt is then mixed in and the whole allowed to cool and settle. The eggs can be added from time to time until the vessel is full, care being exercised to keep at least an inch of the solution above the last layer of eggs. This pickle is good for about two years.

THE MARYLAND

AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 139 OCTOBER, 1909.

NODULAR TAENIASIS, OR TAPE-WORM DISEASE, OF FOWLS.

By Geo. Edward Gage and Chas. L. Opperman.

INTRODUCTION.

The spread of diseases among domestic fowls is a great drawback to the poultry industry in the United States. Perhaps this has never been more noticeable than within the last two months, when an outbreak of Nodular Taeniasis or Tape-worm disease occurred in one flock at the Maryland Agricultural Experiment Station.

The necessity for a discussion of the causative agent found in the intestinal tract, with a description of the special methods for the administration of drugs, may not be at first evident to the reader. However, it is believed that this disease is one of the most deadly which may infect a flock. Hence it was considered of timely interest to the farmer and poultryman to know the cause, the life history of the parasite and the treatment which was found most effective.

It shall, therefore, be the purpose of the present bulletin to emphasize several points of importance and to record observations of the outward symptoms and the internal post-mortem findings, which will be of value in treating an outbreak of the disease.

HISTORY OF NODULAR TAENIASIS.

Tape-worms have for several years been known to infest domestic fowls. The outbreaks which occurred previous to 1895 were confined chiefly to Europe, consequently the results of the investigations on these parasites have been published by Europeans. Only a very few contributions to the study of tape-worm diseases of birds can be found in the English language.

Dr. V. A. Moore, formerly of the Bureau of Animal Industry, United States Department of Agriculture, in 1895 called attention to the nodular form of the disease. He states that the economic importance is much greater than might be considered at first, and gives some interesting facts concerning it. It had appeared in two flocks in the District of Columbia, and from the fact of its occurrence in North Carolina and Virginia is indicative that the infesting parasite is widely distributed throughout the country. He also states, it is highly probable, that the total loss it occasions, both from deaths and the shrink-

age of poultry products, due to the chronic course of the disease, is very large.

At the Maryland Agricultural Experiment Station, and in the surrounding country, an epidemic occurred in 1908. This was quite general. Several cases were reported within a mile of the Experiment Station poultry yards. All the places were visited, and when the birds were examined tape-worms were found in great numbers. It was reported by several that 50 per cent. or more in the flocks had succumbed to the infestation.

Within the last few months several letters have been received at the laboratory inquiring about diseases of fowls. Some described symptoms which suggested that perhaps these parasites were infesting certain birds on the farms.

DESCRIPTION OF THE OUTBREAK AT THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

After careful consideration of the outbreak at this Station, it was concluded that the occurrence was typical of the trouble, which had been reported from time to time in other parts of the State.

The birds affected were Plymouth Rock pullets and cockerels ranging from five to six months of age. Since hatching, they have always been together, even when at free range. Although on the same ground with the other birds, they have kept to themselves.

Attention was first called to the trouble when one of the pullets had died. An autopsy was performed. All the internal organs appeared normal except the intestines, which were filled with gas and exhibited nodular or pea-shaped growths along the outside walls. When these were opened up several tape-worms were found. After careful consideration of the case, it was concluded, inasmuch as the rest of the flock appeared healthy, that probably this was an individual case. The following morning, however, three of the healthiest birds had succumbed to the disease. The autopsies were performed and the conditions noted. In two cases, worms were found by the hundreds. To illustrate the number present, it is only necessary to state, that in one-half inch of the intestines more than fifty worms were counted.

On successive mornings, birds died with almost no outward signs of the disease. All birds on post-mortem examination, however, revealed the presence of worms in great numbers. Prior to death there were no obvious symptoms which would indicate that the bird was infested with tape-worms. It is this which makes the diagnosis important and immediate treatment essential.

The foregoing general statements concerning this outbreak furnish a typical description of other outbreaks, which were reported through correspondence with men engaged in poultry raising throughout the State of Maryland.

POST-MORTEM EXAMINATIONS OF AFFECTED BIRDS.

As soon as tape-worms were determined to be the actual cause of the diseased conditions, a study was begun to obtain a more definite understanding of the disease.

CASE No. 62*

Autopsy was performed August 27, 1909. The subject had lost considerable weight. The heart, lungs and gizzard appeared normal. The intestines were inflated with gas and exhibited the nodules characteristic of the disease. These were confined to the small intestines. When they were opened several small tape worms were found imbedded in the ulcerated depressions along the interior walls. According to the assistant of this department no symptoms, which would indicate serious trouble were observed prior to death.

CASE No. 75.

Autopsy was performed August 27, 1909. The heart, lungs and gizzard appeared normal. The blood vessels along the intestinal tract were engorged with blood. Several small hemorrhages were present. Tape-worms were found by the hundreds filling the intestinal canal at places. The bird was greatly emaciated.

CASE No. 55.

Autopsy was performed September 4, 1909. The heart was engorged. The lungs, spleen and gizzard appeared normal. The blood was mixed with bile. The intestines exhibited several nodules which were a pale yellow color. Worms were present in great numbers. The large nodules contained considerable pus material which extended along the inner layer of the intestinal mucosa for some distance.

CASE No. 58.

Autopsy was performed September 4, 1909. The heart appeared slightly enlarged. The lungs, liver and spleen appeared normal. The nodules along the intestinal canal were very pronounced and were present in great numbers. The photograph on page 77 illustrates the diseased condition of this intestinal tract. This is a clear picture of what to expect in a typical case of nodular Taeniasis.

CASE No. 57.

Autopsy was performed September 5, 1909. The heart and lungs and liver appeared normal. The body cavity was filled with gas. The intestinal canal exhibited several small nodules occurring very close together. When opened many tape-worms were present. They ranged from one-half to two inches in length and at places completely occluded the intestinal canal.

CASE No. 61.

Autopsy performed September 5, 1909. The heart, liver and spleen appeared normal. This bird was badly emaciated. The entire body was in last stage of emaciation. The intestinal canal nearly empty. Few worms found. The wasting effects of disease clearly shown.

CASE No. 63.

Autopsy was performed September 6, 1909. The heart, lungs and liver and spleen appeared normal. This bird was not as badly emaciated as the others. Very few nodules were observed along the intestinal tract.

*No. of Leg Band.

Tape-worms were present. Most of them were more than three inches in length.

CASE No. 67.
Autopsy was performed September 6, 1909. The heart and lungs appeared normal. No nodules were seen along intestines. Few tape-worms were present. Small hemorrhages were located along the interior walls.

CASE No. 71.
Autopsy was performed September 6, 1909. The heart, lungs and liver were normal. The blood vessel appeared inflamed. The lower third of the intestinal tract exhibited several nodules which proved to be the points for the clumping of tape-worms.

CASE No. 73.
Autopsy was performed September 9, 1909. The internal organs appeared normal except a little inflammation was noted. The intestines contained very little fecal matter. Only one small nodule was present on the outside wall of the intestinal tract. Very few tape-worms were found.

CASE No. 74.
Autopsy was performed September 9, 1909. The bird was much emaciated. Nearly all the diseased conditions were restricted to the intestinal tract. The nodules were not confined to the lower parts of the alimentary canal. Several nodules were found at higher levels. The gizzard, heart, liver and lungs appeared normal. Several worms were present. These were the longest found in any of the birds which had succumbed to the dreadful disease.

CASE No. 76.
Autopsy was performed September 9, 1909. All the internal organs appeared normal. The bile had entered the blood stream and the whole interior presented a most horrible appearance. Several very small nodules were seen along the intestinal tract. Very long tape-worms were present.

CASE No. 64.
Autopsy was performed September 12, 1909. Lungs, liver and heart were normal. The intestines contained many tape-worms but the nodules were not as pronounced as would be expected. The interior of the intestine was smeared with blood and the vessels along the tract considerably engorged.

CASE No. 69.
Autopsy was performed September 12, 1909. The bird was greatly emaciated. The internal organs appeared normal except for the lower third of the intestinal tract. Here were exhibited the nodules typical of the disease. Tape-worms were present in great numbers.

The foregoing notes on the post-mortem findings of each bird leads to the following conclusions:

The discovery of nodules along the outside walls of the intestinal tract with tape-worms attached at each nodular spot, within the intestines, indicates that the trouble is Nodular Taeniasis. The following

*No. of Leg Band.

photograph will show clearly typical nodules along the intestinal canal as they appeared in Case No. 58. This nodular affection might be mistaken for tuberculosis, but the diagnoses were distinct, because in all cases attached worms were readily detected by inverting the intestinal tract. Dr. Moore* in 1895 remarks that although the worms may be small, it is possible to detect them, if the affected intestine is opened and the mucous surface washed carefully in a gentle stream of water. The small worms may be seen hanging to the mucous membrane (See Plate I, Fig. 5).

Photograph showing nodules as they appeared in Case No. 58.
(Photo by L. M. Peairs).

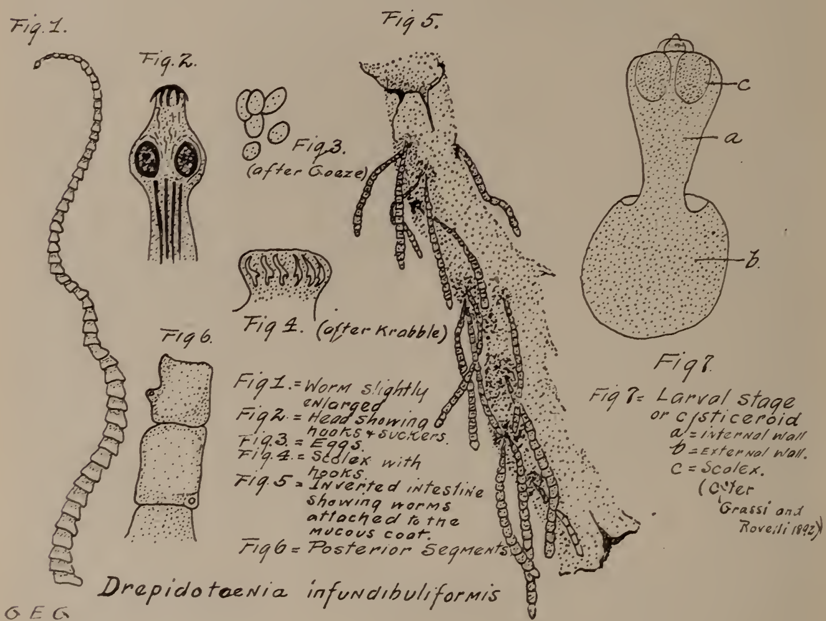
*A nodular Taeniasis in Fowls. Cir. No. 3, Bureau of Animal Industry, U. S. Dept. of Agr.

In nearly all the cases above mentioned, it will be observed that the heart, lungs, spleen and liver were normal. This eliminates the chances of confounding the infection with tuberculosis.

I. DESCRIPTION AND LIFE HISTORY OF THE PARASITES. 2. SOURCE OF INFESTATION.

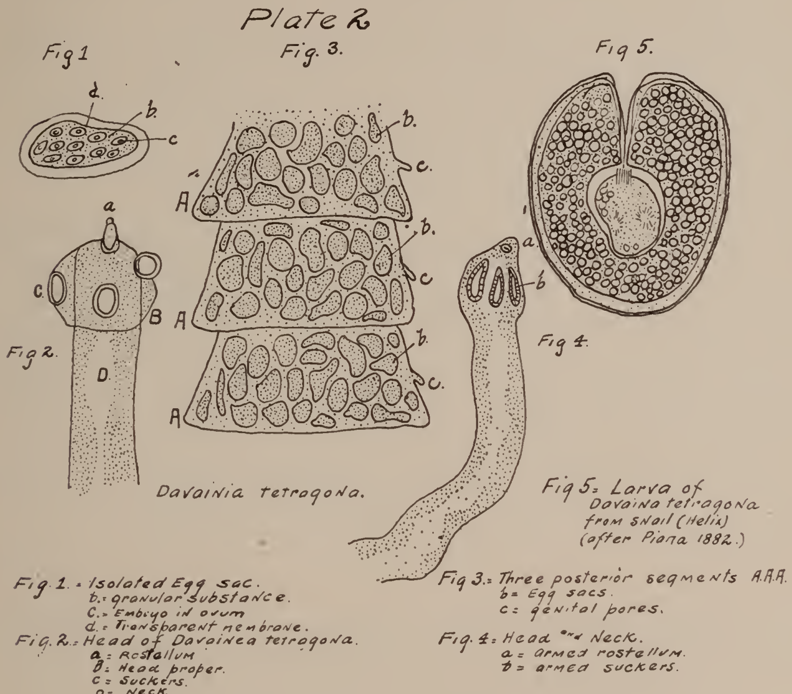
The life history of very few forms of tape-worms is definitely known. After careful examination of the literature on the subject, it is generally conceded that the infestation of the tape-worm is transmitted through an intermediary host. They are adapted to a life of parasitism. They have no digestive system, but are nourished through the general surface (Plate I Fig. 6).

Plate 1.



The soft liquid nourishment is derived from the material within the digestive canal of the host. The tape or flat band is not continuous, but is made up of segments or proglottides (Plate I, Fig. 1). Each proglottid contains vital organs, and in the posterior end of the worm. each segment contains a complete set of reproductive organs. As rapidly as the ova (eggs) are fertilized, they are received into a uterus, which is distended with eggs. The segments drop off one by one and reach the exterior in the feces of the host. In each egg

(Plate 2, Fig. 1), an embryo is present, consisting of a round mass of cells, bearing chitinous hooks. As soon as the egg has been discharged, it has to reach the intestinal canal of a second kind of animal, which is the intermediate host. This is necessary in order that the embryo may enter the next phase of its life history.



The six-hooked embryo (Plate 1, Fig. 4), known as an *oncosphere* or *hexacanth embryo,* bores its way from the intestines into the body cavity of the intermediary host. In the case of tape-worms of poultry, this may be a true worm, snail, crustacean, or an insect. In this intermediary host it develops into a larval form known as a *cysticeroid* (Plate 1, Fig. 7). In turn this larva develops into an adult worm when swallowed by a chicken.

The two worms which were isolated from the affected birds were identified as *Drepidotaenia infundibuliformis* and *Davainia or Taenia tetragona.* The life history of the former is figured in Plate 1, and that of the latter in Plate 2. Grassi and Rovelli* state that the larva of *Drepidotaenia infundibuliformis* may be transmitted to birds through

*Embryologische Forschungen an Cestoden, Centralblatt für Bacteriologie and Pasasitenk, etc., Vol. v, pp. 370-377.

the house fly, as the intermediary host. According to Piana* in 1882 the larva of *Taenia tetragona* was found in snails of the genus Helix. He holds this is a common means of the infestation of tape-worms among domestic fowls.

SYMPTOMS.

The sick birds become emaciated. During the course of the disease at this Station it was noted that the droppings in nearly every case contained considerable yellow mucous. In this material may be found the tape-worm segments (proglottides). Examination for tape-worm segments should be made as soon as possible. The early diagnosis is necessary in order to apply the treatment immediately.

During the last stages, perhaps the last few hours before death, the bird becomes dull and listless. At first the appetite of the bird is in no way disturbed, but when the disease reaches the stage of listlessness, birds begin to lose their appetite, and show a tendency to huddle. Upon post-mortem the intestines in birds examined contained no food; the mucosa or lining was soft and covered with yellowish mucous. On several occasions, the birds suffering with the disease appeared weak and epileptic. The appetite remained normal until the two or three days previous to death, when they became too weak to take food. Most cases exhibited a marked diarrhoea. The feces varied much in color and contained considerable yellow slime. Death came very suddenly, and was accompanied by convulsions.

TREATMENT.

No definite experiments have been made to determine the best treatment for this form of tape-worm disease. In 1895, the studies made by the Bureau of Animal Industry, United States Department of Agriculture, were only preliminary and the records limited.

The first rule to be carried out in all cases of this disease is to isolate the birds from the rest of the flock, and keep them confined until they have recovered. The droppings of all birds known to be infested with the parasites should be destroyed. However, if the manure is to be used for fertilizer, it should be treated with a disinfectant, in order to kill the ova or eggs of the tape-worms.

The chief drugs used for tape-worm infestations are: Extract of male fern, turpentine, powdered kamala, areca nut, pomegranate root bark, pumpkin seeds and sulphate of copper.*[1]

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*Piana, G. P. una nuova specie di Tenia della Gallina, Mem, accad. Sci. Inst. Bologna, Series 4, Tome II (1880-1881) pp. 387-394).

*[1]Tape-worms of Poultry Dr. Ch. Wardell Stiles, U. S. Dept. Agr. 1896, Bull. 12, p. 18.

According to Zurn,*[2] powdered areca nut is the best tape-worm remedy for fowls. He advises the administration of this drug in doses of 30 to 45 grains, mixed with butter and made into pills.

Turpentine is an excellent remedy for all forms of tape-worm infestation. In 1895, the Bureau of Animal Industry, United States Department of Agriculture, made experiments upon chickens in order to determine what doses of turpentine might be administered without danger. Out of 32 chickens dosed with one-half ounce of spirits of turpentine, Dr. Schroeder*[3] reported but one death. These experiments were performed on birds which were not infested with tape-worms, and consequently it was impossible to observe the efficiency of turpentine as a remedy for tape-worms in domestic fowls.

Megnin states that good results followed the use of powdered kamala in one drachm doses. Hutcheon states that pomegranate root bark is very effective against tape-worms in ostriches, but it must be given in large doses and followed by a purgative.

At the Maryland Agricultural Experiment Station the rapidity of the deaths among the flocks necessitated very hasty treatment. Large doses of epsom salts were given, the object being to eliminate the egg-bearing proglottides from the intestinal tract as quickly as possible. The fowls were isolated and the droppings immediately treated with lime, thus removing any chances of further infestation. Turpentine was then administered according to the following method, with the result that all of the birds which were treated were saved.

In 1908, when birds were found suffering with the nodular form of the disease the following drugs were administered and the effects noted:

CASE No. 181*
Pomegranate root bark was given in a warm mash. This was followed by a dose of epsom salts. This did not give satisfactory results.

CASE No. 136.
Extract of male fern was given with a medicine dropper. The dose administered was 30 drops. This failed to dislodge the worms. Results as a whole were unsatisfactory.

CASE No. 184.
Powdered Santonin was mixed in the food to the extent of 8 grains to each bird. This proved unsatisfactory. There were no reactions.

CASE No. 190.
Epsom salts, administered in 50 grain quantities gave results. This was given in liquid form by means of a medicine dropper. Segments of tape-worms were noted in the droppings.

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*[2]Zurn, Die Krankheiten des Haus geflügel, Weimar, pp. 279.

*[3]Schroeder, Tape-worms of Poultry, Stiles, Bull. 12, p. 19, U. S. Dept. Agr. 1896.

*No. of Leg Band.

The four birds were then isolated in one pen, and treated with a heavy dose of epsom salts, followed by pomegranate root bark in the mash. In one week they recovered, and in a short while had overcome the infestation to all appearances.

In view of this preliminary work, it was decided that the administration of epsom salts, in a quantity sufficient to immediately disperse the worms from the tract, is important. Then feed should be given, and the turpentine introduced directly into the crop. This is the quickest way of treating this infestation which develops so rapidly after the first symptoms appear.

EXPERIMENTATION WITH EPSOM SALTS AND TURPENTINE.

The first question which confronts the poultryman is how much salts to administer to birds which are infested with these parasites. It is absolutely necessary to know how much to give, and how long it will take to act. In order to determine this, a line of experimentation was planned.

Epsom salts may be given advantageously in two ways, (a), by dissolving the salts in warm water, and using this solution to moisten the mash or feed; and, (b), by dissolving the salts in warm or cold water and giving each fowl this liquid.

In the treatment of fowls from six months to two years of age the latter method was found preferable. It is quicker and more certain in its action. The former method may be used for young birds from one week to six months old. Experience has shown that when the salts are administered in the mash for a flock, some of the birds do not receive a sufficient amount of salts to purge the intestines thoroughly. This is due to the uneven distribution of the salts in the food. The weaker birds are unable to get enough mash, because they are crowded away by the stronger ones.

In administering salts, each bird must receive a sufficient amount to effect a thorough cleaning out of the intestinal tract. The following table shows the results of the experiments made to determine the dose of salts necessary to clean out the intestinal tract of a bird suffering from tape-worm infestation:

Table Showing the Effects of Epsom Salts in Different Quantities.

BIRD NO.	AGE	AMOUNT	TIME REQUIRED FOR EFFECT
102	2 Years	15 grains	From 4 to 6 hours
106	" "	15 "	Effect slight
107	" "	25 "	From 4 to 5 hours
121	" "	25 "	Purgative effect marked
201	" "	30 "	From 4 to 6 hours
215	" "	30 "	Purgative effect marked
162	" "	40 "	
148	" "	40 "	
193	" "	40 "	From 4 to 5 hours for a
204	" "	40 "	good purgative effect
98	" "	40 "	
76	" "	40 "	
91	" "	50 "	From 2 to 5 hours
83	" "	50 "	Purgative effect good
122	" "	60 "	From 1 to 3 hours (good)
136	" "	70 "	From 1 to 3 hours (very strong)
212	" "	80 "	From 1 to 2 hours
190	" "	80 "	Purgative effect, very marked

After careful consideration of the data in the above table it is concluded that a dose of 40 to 50 grains is sufficient for an adult fowl in order to clean out the intestinal tract, so that the bird may take food. Then the turpentine should be introduced.

The following table has been prepared as a guide for the administration of salts to produce a marked purgative effect in birds of different ages:

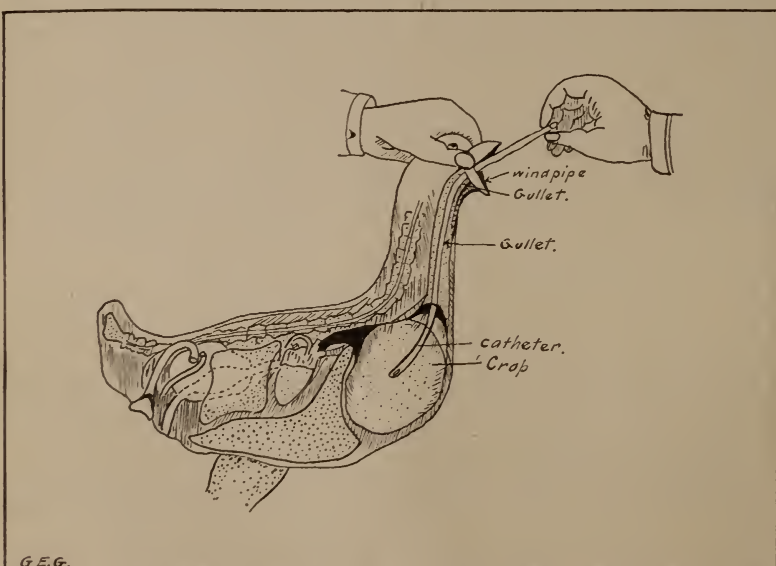
Age of Bird	Amount Per Bird in Grains	How Administered
1 to 6 weeks..........	10 grains	In feed
5 to 10 weeks 7.......	15 grains	In feed
10 to 15 weeks..	20 grains	In feed
15 weeks to 6 months	30 grains	Two teaspoonful of water
6 months to 1 year.....	35 grains	to every 30, 40 or 50
1 year and over........	40-50 grains	grains of salt

To facilitate figuring quickly the number of ounces which would be required for treating several birds, the following is inserted:

1 pound, avoirdupois equals 7,000 grains.
1 ounce, avoirdupois equals 437½ grains.
1 pound, Troy or apothecary equals 5,760 grains.
1 ounce, Troy or apothecary equals 480 grains.

METHOD FOR ADMINISTERING TURPENTINE.

A soft rubber tube or catheter will serve very well for this purpose. The end of the rubber tube or catheter should be immerged into the turpentine, which may be retained in a small cup. This is sucked up with the mouth into the tube, the finger placed over the end, thus



Sketch showing method of introducing Turpentine directly into Crop.

holding the liquid by suction. From two teaspoonfuls to one-half ounce may be given in such manner. Holding the mouth of the bird open, as pictured in the sketch, the catheter or tube is pushed down the gullet until it reaches the crop. The finger is then removed and the turpentine discharged directly into the crop. By such a method the turpentine passes immediately into the intestines and destroys the heads of the worms left behind after the purgative has torn away the long ribbon-like band of segmented of the parasite.

At first this may appear to be a long method, but experience has taught that it is very effective, and is more than worth the trouble.

There are some who think time is wasted in treatments of this kind. They say it does not pay to bother with sick fowls. This is not true. If the farmer or poultryman will follow strictly this method of treatment, he will be able, by a few hours' work, when the disease first shows itself, to eradicate the disease and prevent the loss of perhaps six months' or two years' work spent in rearing the fowls.

Doubtless, there are many individual cases where it does not pay to treat sick fowls, but with "Nodular Taeniasis," it is certain, that if the treatment is administered soon after the appearance of the first symptoms, recovery for the flock is almost assured. Immediate treatment will result successfully, and the poultryman has saved time and money.

Dr. Fischer sums up the situation very well in his recent article.* "The commercial poultryman who thinks he has not time to look after sick birds saves time by destroying them as soon as they come to his notice, but he undoubtedly kills many birds which would be worth saving, if he could give them some care and attention."

Men engaged in the industry often ask: Does it pay? Certainly it will pay anyone to inform himself about the ordinary diseases which birds are liable to develop, and to keep them, when they get sick, until he can distinguish the mild and transient cases from the severe and dangerous; to know when to destroy and when to look for recovery.

CONCLUSIONS.

After a careful consideration of the outbreak, as it occurred at the Maryland Agricultural Experiment Station, the following conclusions would seem to be justified:

(1) Nodular Taeniasis is a specific disease infecting poultry, and is one of the most deadly which may affect the flocks.

(2) The symptoms are not distinct, but are marked by a dullness and listlessness only previous to death.

(3) On post-mortem examination, if the case is typical of Nodular Taeniasis, nodules and tape-worms will be found in the intestines.

(4) Epsom salts and turpentine, when administered as directed in the foregoing pages, have proved to be the most effective agents for allaying the troubles arising from the disease.

*Successful Poultry Journal, Oct., 1909, page 10.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 140. NOVEMBER, 1909.

THE SAN JOSE SCALE AND OSAGE ORANGE HEDGE.

By T. B. Symons and L. M. Peairs.

INTRODUCTION.

Notwithstanding the large amount of literature issued during the past few years dealing with the habits and control of the San Jose scale, there continue from time to time many requests concerning it. Even from those who have been combating the pest for years, there seems to be an unusual demand for the latest results from new remedies, which are being placed on the market. While many growers still cling to the home-made lime sulfur wash, which is established to be the most effective and cheapest, yet a large majority desire something which can be more easily made and applied. The prevailing question, therefore, at this time is not what solution is effective in controlling the scale, but what solution combines effectiveness, ease of application and cheapness to the greatest degree. The labor problem has undoubtedly forced many growers to use a solution which can be handled and applied with the least trouble. Commercial manufacturers have recognized this condition, as well as the desire of growers to use lime sulfur in some form, and accordingly have placed on the market several brands of concentrated lime sulfur preparations.

In order that this department may be in a position to speak intelligently on the value of the various new spray solutions on the market, the tests reported in this bulletin have been made.

This department was fortunate in securing orchards for the tests which were very badly infested with the scale, thus furnishing an excellent opportunity for the various solutions to prove their worth.

The department is pleased to acknowledge the co-operation afforded by Mr. John Bell, of Chestertown, Schaffer Brothers, of Boonsboro, and Mr. R. P. Beckley, of Halfway, Maryland, in the use of their orchards, for conducting the tests, and desires to especially thank them for the labor supplied in application of the solutions. Credit is due Messrs. W. C. Travers and R. E. Herr for their faithful service in the application of the washes.

One of the greatest factors in the perpetuation of the San Jose scale in Maryland at this time is the Osage Orange hedge. This hedge is a nuisance on fruit farms. Hedges abound in many parts of the State, and not one has been found to be free from scale.

Inasmuch as the department has recently adopted the policy of requiring either the treatment or the destruction of these hedges, it is thought desirable to give here the reasons for so doing.

The success in operating public sprayers, warrants a further mention of this phase of the work, in order to interest private parties in this business. This bulletin, therefore, is issued to give the results of the tests conducted by this department during the past season, and to make recommendations for future treatment against this pest.

SPRAYING EXPERIMENTS.

In order to keep fully and accurately informed as to the relative merits of the various products placed on the market from time to time by different manufacturers, this department finds it necessary to procure such spray solutions as seem of sufficient importance to demand attention, and to make as thorough and extensive tests of the same under typical conditions, as may be possible. These tests were made under the personal supervision of this department, and every effort was made to have them thorough and accurate. Careful observations were made at intervals during the season, and the results are kept on record.

The tests the past season include not only the products new to the market, but also several of the older and more widely known and used spray materials, and these were all used in comparison with the home-made lime-sulfur wash.

Both peach and apple trees were used in the experiments, but a larger number of different mixtures was applied on peach trees than on apple. Several tests were made to determine the value of the same materials applied in fall and spring on apple and peach.

In order to eliminate variations due to soil and climate, parallel experiments were conducted, one in Western Maryland and one on the Eastern Shore. Two very similar peach orchards were obtained for this purpose, one located at Boonsboro, Washington county, and the other at Chestertown, Kent county. The trees in both orchards were quite uniformly and badly infested with scale, and were admirably adapted for the tests.

The apple orchard, where several tests were employed, is situated in Washington county, and contained trees badly infested, and small enough to permit thorough spraying. Both fall and spring tests were applied in the apple and peach orchards in Washington county.

An old apple orchard on Mr. Bell's place, at Chestertown, was also thoroughly treated with the Orchard Brand Solution in comparison with the home-made lime sulfur. These trees were of large size, some of them being badly infested, while others were only moderately infested with scale. The following is a list of the tests made and a brief statement of the results obtained with the various solutions employed.

HOME-MADE LIME SULFUR.

Mixed according to the standard formula, 20 pounds lime, 15 pounds sulfur to 50 gallons water. This was included in the tests as a basis of comparison for the other washes. It was used only in the apple and peach orchards at Chestertown, where it gave most excellent results.

ORCHARD BRAND LIME SULFUR.

A liquid preparation, manufactured by the Thomsen Chemical Company, Baltimore, Maryland. It was used for fall and spring spraying in the apple and peach orchards. A much larger number of both apple and peach trees were sprayed with this solution than with any of the others, on account of its being easily secured and quite generally used in the State the past spring. The strengths used were 1-9 and 1-10. These strengths were tested both with and without additional lime added in the form of milk of lime.

The results from Orchard Brand were uniformly excellent in both the fall and spring work on peach, and also satisfactory on apple. No difference could be observed in the final results where extra lime was used.

Only a slight difference could be detected in favor of the home-made solution, in the comparative tests of the two washes applied on apple in the Bell orchard, and the results were practically the same in the extensive tests of these washes on the peach trees at this place. It is recommended that this solution be used at the strength of one gallon of the Lime Sulfur Solution to nine gallons of water.

ORCHARD BRAND LIME SULFUR WITH SEDIMENT.

This solution was secured from the Thomsen Chemical Company, Baltimore, Maryland, at our special request. It is similar to the regular solution, except the sediment was not settled out. It was thought that this solution would approach more nearly the home-made solution. It was applied on peach trees in the Bell orchard at both 1-9 and 1-10.

Final examination revealed no difference in effectiveness between this and the company's regular solution, but the trees showed somewhat whiter after the application in the spring.

REX LIME SULFUR.

Prepared by the Rex Company, of Omaha, Nebraska, in liquid form. Used in the orchard at Chestertown at 1-9 and 1-10, both with and without extra lime, and at Boonsboro at 1-9 and 1-10 in the spring and fall. The results obtained with it were excelled by none, as it was effective on all peach trees to which it was applied. It was also used on apple trees in the fall with very satisfactory results.

NIAGARA BRAND LIME SULFUR.

Manufactured in liquid form at Middletown, N. Y., by Niagara Spray Company; sprayed on peach trees in the Boonsboro orchard only, at strengths of 1-9 to 1-10. At 1-9 it was quite satisfactory, but the results were noticeably poorer at 1-10.

SWIFT'S LIME SULFUR.

A powdered preparation made by the Merrimac Chemical Company, Boston, Mass. This was applied in the Boonsboro orchard at the strength of five pounds to five gallons of water and five pounds to eight gallons of water. It is prepared for use by mixing to a paste with cold water, and then adding the required amount of cold water, no cooking being required. The samples used sprayed well, and did not clog the pump or nozzles.

The results from the stronger mixture were entirely satisfactory, comparing favorably with the best, and even at the strength of five pounds to eight gallons of water, it may be considered effective.

NEVER SCALE.

A powdered lime sulfur, put up by the Sulfo-Chemical Company, Philadelphia, Pa. Used in orchards at Boonsboro and also at Chestertown, at strengths of 50 pounds to fifty gallons, 50 pounds to forty gallons and 50 pounds to eighty gallons. To prepare this for use, it is necessary to boil for about five minutes with a small quantity of water and then dilute to the desired strength. It sprays well and covers the tree nicely. At the rate of 50 pounds to fifty gallons and 50 pounds to forty gallons, results were satisfactory, but they were less so at 50 pounds to eighty gallons of water.

BOGART'S SULFUR COMPOUND.

A liquid spray, manufactured by W. H. Bogart, 24 Grove street, New York. Applied at the strength of 1-20 and 1-15, in both the Chestertown and the Boonsboro orchards. Mixes well with water, and is not irritating to the skin.

At 1-15 the results were excellent, but at 1-20 they were not uniform, being very good at Chestertown and scarcely satisfactory at Boonsboro.

COOPER'S TREE SPRAY, V^1.

A liquid spray, manufactured by William Cooper & Nephews, Chicago, Illinois. The manufacturers recommend a dilution at the rate of one gallon to 100 gallons of water. It was used in both orchards at this strength, and at the rate of one to 50, but did not prove efficient at either strength.

SCALECIDE.

Scalecide is a soluble or miscible oil prepared by the B. G. Pratt Company, New York, N. Y.

Scalecide was used for fall test at 1-15 in the Boonsboro orchard, and in the spring at the same strength in the Chestertown orchard. While the results obtained with the oil at 1-15 were very good, it can scarcely be considered as efficient as some of the lime sulfur mixtures. At 1-20 the results were more or less irregular. It mixes perfectly with water.

ORCHARD BRAND SOLUBLE OIL.

This is a miscible oil, manufactured by the Thomsen Chemical Company, Baltimore, Maryland. It was applied in spring and fall at 1-15 at Boonsboro, and in the spring at 1-15 at Chestertown. Mixes well with water and is readily applied. The results in all cases were satisfactory.

SAN-U-ZAY.

San-U-Zay is a soluble oil distributed from Rochester, New York, by the F. G. Street Company. It is thicker and less readily miscible with water than any of the other oils used, and it is necessary to add from three to five pounds of sal soda to fifty gallons of water to obtain an emulsion. Used in the Boonsboro orchard both spring and fall at strength of 1-15. It killed the scale very well, but the spring application killed a considerable amount of wood in the tops of the trees, so that its use at this strength would seem unadvisable, until further tests have been made.

TARGET BRAND.

A soluble oil manufactured by the American Horticultural Distributing Company, Martinsburg, W. Va. Applied at the rate of 1-15 in the Boonsboro orchard in November, and did not prove satisfactory.

SUMMARY OF RESULTS.

Peach Tests.

Undoubtedly exceptionally good results were secured from the majority of the solutions used. Each orchard was in a very serious condition from the effects of the scale, the trees being practically abandoned by the owners as beyond saving by treatment. Their recovery in some cases was surprising.

These results demonstrate what can be accomplished by thorough application of remedies. However, the solutions were applied under favorable conditions, and an exceedingly dry summer followed, which aided in prolonging the effect of many of the washes.

Several solutions, namely: Orchard Brand Lime Sulfur, Rex Lime Sulfur, Soluble Oil, Swift's Lime Sulfur at one pound per gallon, and Bogart's Sulfur Compound at 1-15 gave uniformly excellent results. Others, Scalecide (1-15), Niagara Brand, L. S., and Neverscale at 50 pounds to fifty gallons were not far behind in efficiency.

Weaker strengths of some of these mixtures, as well as Cooper's V1. and Target Brand did not prove satisfactory. San-U-Zay, while fairly satisfactory for the fall spraying and effective against the scale in the spring, caused very serious injury to the tops of those trees to which it was applied in March.

Apple Tests.

In November, 1908, forty badly infested trees in the Beckley orchard were sprayed with Orchard Brand Lime Sulfur Solution at 1-10. An equal number was treated with Orchard Brand Soluble Oil at 1-15, and about 25 trees were sprayed with Rex Lime Sulfur Solution at 1-10.

In March, 1909, eighty trees in the same orchard were sprayed with Orchard Brand Lime Sulfur at 1-10 and fifty more with the same material at 1-9; also about 150 old trees in the Bell Orchard, some of which were badly infested, were treated with the home-made lime sulfur wash and the Orchard Brand Lime Sulfur Solution.

Careful observations failed to reveal any marked difference in effect of the various mixtures or dates of spraying, on the scale, as the results were all very good. However, some of the badly infested trees that were sprayed in the spring died, while equally infested trees sprayed in the fall survived, indicating that for very badly infested orchards, the best practice is to spray as soon as possible in the fall, and perhaps give a second treatment in the spring. No difference in results could be noted between the various lime sulfur treatments and soluble oil.

FALL AND SPRING TESTS.

As indicated, both apple and peach trees were sprayed with different solutions, viz: Orchard Brand Lime Sulfur, Soluble Oil, Scalecide, San-U-Zay and Rex Lime Sulfur in fall and spring. A comparison of the results in these experiments fails to show any difference in the amount of scale killed; but in case of the San-U-Zay Oil, the peach trees sprayed in November were not injured by the oil, while those sprayed in March were quite seriously injured.

While spring spraying is believed to be preferable, except in bad cases requiring two treatments, yet undoubtedly in some cases the spraying can be done more conveniently in the fall.

TABULATED SUMMARY OF RESULTS.

All trees were uniformly badly infested with the San Jose scale. Examination of the tests were made at different times during the summer; the final records were taken August 27th and September 10th in the different orchards.

Spray Mixture Used	Strength	Date	Place	No. of Trees	Kind of Trees	Effect in Killing Scale
Lime Sulfur, Home Cooked	20-15	Mar. 19-09	Chestertown	400	Peach	Excellent
Orchard Brand Lime Sulfur	1-10	Nov. 23-08	Boonsboro	44	"	"
" "	1-10	Mar. 19-09	Chestertown	75	"	"
" "	1-9	Mar. 22-09	Boonsboro	47	"	"
" "	1-9	Mar. 20-09	Chestertown	140	"	"
Orchard Brand with Lime	1-9	Mar. 20-09	Chestertown	12	"	"
" "	1-9	Mar. 21-09	Boonsboro	18	"	"
" "	1-10	"	"	10	"	"
" "	1-10	Mar. 20-09	Chestertown	124	"	"
Orchard Brand Lime Sulfur with sediment	1-9	Mar. 19-09	"	8	"	"
Rex Lime Sulfur	1-10	Nov. 22-09	Boonsboro	12	"	"
" "	1-10	Mar. 20-09	Chestertown	7	"	"
" "	1-10	Mar. 18-09	Boonsboro	15	"	"
Rex with Lime	1-10	Mar. 19-09	Chestertown	7	"	"
" "	1-9	"	"	7	"	"
Rex Lime Sulfur	1-9	"	"	7	"	"
" "	1-9	Mar. 20-09	Boonsboro	20	"	"
Niagara Brand Lime Sulfur	1-9	"	"	11	"	Very Good
" "	1-10	"	"	12	"	Fair
Neverscale	50-50	Mar. 24-09	"	43	"	Good
" "	50-50	Mar. 20-09	Chestertown	20	"	Very Good
" "	50-40	"	"	4	"	"
" "	50-80	Mar. 23-09	Boonsboro	8	"	Fair
Swifts Lime Sulfur	50-50	Mar. 23-09	"	50	"	Excellent
" "	50-80	"	"	22	"	Very Good

Spray Mixture Used	Strength	Date	Place	No. of Trees	Kind of Trees	Effect in Killing Scale
Sulfur Compound	1-20	Mar. 19-09	Boonsboro	12	Peach	Fair
" "	1-20	"	Chestertown	22	"	Excellent
" "	1-15	"	"	23	"	"
Scalecide	1-15	Nov. 24-09	Boonsboro	30	"	Very Good
" "	1-20	Mar. 24-09	"	18	"	Good
" "	1-15	"	"	16	"	Very Good
" "	1-15	Mar. 19-09	Chestertown	48	"	"
Soluble Oil	1-15	Nov. 24-08	Boonsboro	39	"	Excellent
" "	1-15	Mar. 19-08	Chestertown	18	"	"
" "	1-15	Mar. 20-09	Boonsboro	18	"	"
Target Brand	1-15	Nov. 23-08	"	12	"	Fair
San-U-Zay	1-15	"	"	32	"	Very Good
" "	1-15	Mar. 19-09	"	21	"	"
Coopers V1	1-100	"	Chestertown	22	"	Poor
" "	1-50	"	"	18	"	"
" "	1-50	Mar. 22-09	Boonsboro	9	"	"
" "	1-30	"	"	13	"	"
Orchard Brand	1-9	Nov. 19-08	Halfway	40	Apple	Very Good
Rex Lime Sulfur	1-9	"	"	25	"	"
Soluble Oil	1-15	"	"	40	"	"
Orchard Brand Without Lime	1-9	Mar. 26-09	"	40	"	"
Orchard Brand With Lime	1-9	"	"	10	"	"
Orchard Brand Without Lime	1-10	"	"	50	"	"
Orchard Brand	1-9	"	Chestertown	100	"	"
Home Made Lime Sulfur	20-15	Apr. 2	"	120	"	"

RECOMMENDATIONS.

From the results of these tests and general observations over the State the past season, it would appear that the concentrated lime sulfur solutions have reasonably demonstrated their ability to compare favorably with the home-made wash in holding the San Jose scale in check. It may be said, however, that conditions that usually enter into success of such treatments have been exceedingly favorable the past season. The favorable results, therefore, should not be considered as conclusive, for too much dependence should not be placed on the results of one season's work.

In one or two instances it has been observed that the concentrated Lime Sulfur Solutions did not prove entirely successful in checking the scale on apple. While very good results from these washes were secured in tests on apple, yet some of the miscible oils may be employed with an equal and possibly a greater degree of success on account of the fact that in ordinary spraying the miscible oil will spread on the hairy twigs of apple more readily than the Lime Sulfur Solution. In the tests with the concentrated lime sulfur and the Soluble Oil on apple no difference in results could be detected.

These tests indicate that the concentrated Lime Sulfur Solution should not be used weaker than one gallon of the solution to nine gallons of water. In case of bad infestation, a greater strength may be used. The use of the concentrated Lime Sulfur Solutions rather than the home-made wash, is a matter for the individual to decide. In many instances the home-made wash will still be employed, for it is undoubtedly the cheapest for those who are prepared for making it, and its effectiveness, when properly prepared and thoroughly applied, may be relied upon.

Practically no difference could be detected in their effect on the leaf curl of peach trees between the home-made and concentrated Lime Sulfur Solutions. Cases were observed where considerable leaf curl was present, both in orchards that had been thoroughly treated with the home-made wash and the concentrated solution; while in other cases no curl was present in orchards where either wash had been used. The results from observations over the entire State, indicate plainly that the Lime Sulfur Solutions were of much benefit in preventing an injurious amount of this disease. We continue to believe that the Lime Sulfur Solutions offer the safest and most generally satisfactory remedy for the San Jose scale.

DIRECTIONS FOR MAKING LIME SULFUR WASH.

Inasmuch as former Bulletins, containing directions for making the Lime Sulfur Wash, are exhausted, and as there are many persons who are not as yet familiar with its use, it is deemed advisable again to give what is considered the best formula and the method of making it. There is considerable latitude in the quantity of materials used,

and the manner of making the mixture within which uniformly good results may be obtained. The materials may be boiled in a home-made vat or hog scalder, or if steam is desired, a small boiler or a regular steam engine may be employed where it is desired to make the wash on a large scale.

There is practically no difference in the use of flour or flowers of sulfur in making the wash, and as the flour of sulfur is the cheaper it would seem more practical to employ this grade.

Formula:

Stone lime	20 lbs.
Flowers or flour of sulfur	15 lbs.
Water to make	50 gal.

Directions—Put twenty gallons of water in an iron vat, or hog scalder, and bring to a boil; then add the stone lime and sulfur. The sulfur should be made into a paste, with hot or cold water, before placing it in the boiler, in order to facilitate its mixing. Boil the mixture, stirring occasionally, from thirty minutes to one hour, or until the sulfur is completely dissolved, and a clear amber-colored solution produced. Then dilute by adding sufficient hot or cold water to make fifty gallons. Pass the mixture through a strainer, with at least twenty meshes to the inch, into the spray barrel, and apply while warm to the trees.

TIME OF APPLICATION.

No particular difference has been observed in the effectiveness of the Lime Sulfur Wash, whether applied in the fall or early spring, during the dormant season. It is believed, however, that early spring is the best time to spray, as the mixture will remain on the trees for a longer period during the summer, when the scale is breeding, and this is desirable. In some cases, where there is a great amount of spraying to be done, it may be necessary to do a part of it in the late fall, as often in the spring weather conditions make a short period for spraying; also other spring work may interfere. It is safe to say that 90 per cent. of the spraying in Maryland is done in the spring, and there is little doubt but that period is preferable. It must be borne in mind that the lime sulfur wash is a treatment for dormant trees, and should not be applied after the buds open in the spring.

MODE OF APPLICATION.

No matter how good the materials used, or how well the wash is made, if the spraying is not done thoroughly, the results will be disappointing. Too much stress cannot be laid upon this phase of the work. One of the advantages of the lime sulfur wash is, that after the spray has dried on a tree, the twigs or limbs that have been missed are easily seen. Such trees should be gone over a second time; especially should the terminal parts be thoroughly covered, as the young insects always seek the new, tender wood.

If a few infested trees have been found in an orchard, spray the whole orchard. The pest is always more widely distributed than an inspection would ordinarily indicate.

In the selection of a pump for spraying purposes, the particular size, etc., is left to the judgment of the orchardist. The majority of the pumps on the market will give satisfaction, and conditions under which spraying is done are so varied that only general recommendations can be made. There is no doubt that the ordinary barrel pump is more generally used than other kinds, but the power sprayers and double-acting pumps have their place, where there is a large amount of work to be accomplished.

Spraying, at best, with any insecticide or fungicide, is rather disagreeable work, and the sprayman should be fitted out with rubber or oilskin coat, hat and glcves. It is also a good plan to rub vaseline on the hands and face to prevent the spray from irritating the flesh. Make it a point to have a sufficient length of hose—twenty feet to each lead, should be the minimum length for orchard work. This will enable the spraymen to go all around an ordinary size tree without moving team. Good extension rods are necessary, and will aid in keeping out of the spray. What is stated above in regard to the different pumps, may also be said of the different nozzles on the market. Some prefer the fan-shaped, others a conical spray.

In conclusion, select the apparatus best suited to your needs, and conduct the work in a thorough manner.

The following are manufacturers and dealers in pumps and supplies:

Griffith & Turner Co., Baltimore, Maryland.
Goulds Manufacturing Company, Seneca Falls, N. Y.
The Demming Company, Salem, Ohio.
Morrill & Morley, Benton Harbor, Michigan.
Field Force Pump Company, Elmira, N. Y.
Myers Pump Company, Ashland, Ohio.
George H. Stahl, Quincy, Illinois.
Spray Motor Company, Buffalo, N. Y.
L. G. Orndorff, No. 203 Seventh street, Washington, D. C.
F. W. Bolgiano & Co., No. 935 M street, N. W., Washington, D. C.

THE OSAGE ORANGE HEDGE PROBLEM.

As mentioned in the introduction, Osage Orange hedges abound in many parts of the State, both on the Eastern and Western Shores. In some instances this is practically the only fence on the farm. It thus serves as a division fence between farms as well as a supposed barrier for farm animals between fields. No more striking case could be cited to demonstrate to farmers the conservatism which they should practice in purchasing any new plants or other articles that have not been tried and found satisfactory for their needs. The writer has not interviewed a single farmer in Maryland who has such a hedge on his

place who does not regret purchasing the plants. Unfortunately, aside from the natural reluctance of the farmers to lose the first cost, and perhaps many years of expense in maintainance, it is expensive to grub up the hedges, and this is in the majority of cases, the only excuse for their existence on so many Maryland farms.

DISTRIBUTION.

While the Osage Orange hedge can be found in every county of the State to a greater or less extent, it is especially abundant in Cecil, Kent, Queen Anne, Talbot and Dorchester counties of the Eastern Shore, and Washington, Frederick, Carroll, Howard, Baltimore and Harford on the Western. Perhaps Washington, Frederick, Kent and Queen Anne counties are most badly afflicted with this nuisance. In these counties, there are undoubtedly many more miles of hedge than county roads. It is rather peculiar, that in these counties the fruit interests are far more predominant than in any other counties of the State.

A NUISANCE ON THE FARM.

The primary inducements held out for planting Osage Orange hedge are that it will furnish a substantial fence at comparatively small initial cost, and that such a hedge furnishes an attractive fence on the farm. If these claims proved true, there would be some excuse for maintaining the hedge. But years of experience have failed to substantiate these claims.

Seldom is there seen a hedge that will serve as a proper fence. If it serves as a barrier to horses and cattle, it will have holes permitting hogs and sheep to pass through, and as a whole may be considered worthless in barring our domestic animals.

While repairing is from time to time necessary, it is seldom practical. This expense added to that of trimming the hedge every year to keep it in a presentable condition, is more than enough to offset the cost of erecting and maintaining a good wire fence. The hedge should be given one or even two or more trimmings each season. This is expensive and a very disagreeable operation, principally on account of the thorns.

The Osage Orange plant is a very vigorous grower; its roots permeate the ground on each side of the hedge for at least ten feet, and in many cases greater distances. It thus robs the soil of fertility and moisture that should be accessible to crops planted in the field.

The hedge furnishes abundant food for the San Jose scale, and as this pest is generally disseminated over the central and eastern parts of the State, it follows that practically every hedge is infested. Unfortunately the plant is so vigorous that the scale will seldom kill it outright. Often the scale will kill a year's growth, but the roots will put up new shoots the following season. As hedges are frequently visited by birds of all kinds, and as birds are a means of disseminating

the young scale insects, a hedge in any locality will serve to infest fruit trees a considerable distance from it.

In many districts fruit growers may be found who are treating their fruit trees regularly for San Jose scale, while their neighbors, who may not be directly interested in fruit growing, are maintaining Osage Orange hedges on their farms, which serve as harbors for scale, from which it may be distributed throughout the neighborhood. This is manifestly unfair, and is of course the reason that prompts this department to discuss the problem. It is believed, moreover, that aside from its being an important and widespread food plant for the San Jose scale, the Osage Orange hedge should be removed from all farms as early as possible for other economic reasons.

POLICY ADOPTED BY THE DEPARTMENT.

The State Horticultural law requires that all infestations of San Jose scale be either treated or destroyed. For the protection of the growers in the vicinity, the law is enforced, as far as our funds will permit, against neglectful growers, who maintain a few fruit trees which are badly infested with the scale. The law is rigidly enforced in the inspection of nurseries in the State. Osage Orange hedges, therefore, must be considered in the same catagory, and those who maintain them on their premises must comply with the law either by treating or by destroying them.

As mentioned previously, every owner of a hedge is desirous of destroying it, yet the time, trouble and expense incident to its destruction cause many to neglect it. Considering this condition, and the widespread distribution, the department has adopted the policy of allowing farmers three years in which to rid their property of this nuisance. Thus the hedge bordering on the fields to be cultivated each season can be destroyed. This method will not work a hardship on the owner or tenant, and will serve gradually to eliminate this important breeding ground and food plant of the San Jose scale.

In cases where the owner desires to maintain such a hedge it will be necessary to have it sprayed annually for scale. Even in cases where owners adopt the policy of gradually destroying all hedges, if the hedges remaining during this period are in close proximity to neighbors' orchards, they will be required to be treated with an effective remedy once a year.

SPRAYING OSAGE HEDGE.

In cases where the hedge is a standing menace, and circumstances will not permit its being destroyed, it can be sprayed with remedies similar to those employed on fruit trees to control the scale. Any of the Lime Sulfur Solutions or miscible oils that are effective may be used. Undoubtedly if a large amount of hedge is to be sprayed, the use of one of the reliable miscible oils is desirable. There are many

small branches to be covered, and as the oil has a greater capacity to spread than the lime sulfur preparations, and there is no danger of it injuring the plant, the oils are more efficient. Hedges should be sprayed while in the dormant state, preferably in early spring.

Fortunately Osage Orange hedges that have reasonable attention are not difficult to spray. They are usually cut back to three or four feet, which permits the sprayman to apply the spray, standing on the ground. In spraying a hedge with a barrel pump or power sprayer, it is economical to have two leads of hose, directing the nozzles against each side of the hedge.

DESTRUCTION.

The most economical manner of destroying the Osage hedge is largely a matter of individual opinion, and the most convenient time will depend upon various conditions on the farm. It is a waste of time to cut down the hedge without grubbing up the roots. In many cases a traction engine is employed to pull up the hedge, and undoubtedly where special labor must be employed its use is desirable.

MISCELLANEOUS HEDGES.

One of the preferred food plants of the San Jose scale is Pyrus Japonica. Occasionally this plant is used to form a hedge for ornamental purposes. This department has recently been compelled to condemn such a hedge on account of it being a menace to the neighborhood in harboring scale. The Hawthorn is sometimes planted as a hedge. This is also a food plant of the scale. If such hedges are desired, it will be necessary to spray them annually for the scale.

Fortunately California Privet, which is now being so generally used for a hedge in landscape designs, is seldom attacked by San Jose scale. In only one case has this plant been found to be infested in the State, and this was undoubtedly due to a very bad infestation of scale that surrounded it. Ordinarily privet is immune to the pest.

PUBLIC SPRAYERS.

Among the small growers, especially those living in the suburbs of cities, and in towns and villages, who have only a few trees for home use, there is a great demand for public sprayers. These persons are usually eager to have their trees properly treated, if they can have such work done at a reasonable cost. In many villages it is not an uncommon occurrence to observe every fruit tree growing in the vicinity badly infested with the scale. Usually the trees are held in high esteem by the owners, who seldom are able to detect the scale until the trees are quite badly infested.

In order to aid this class of growers by furnishing means whereby they could have their trees treated, this department has been conduct-

ing public sprayers in different parts of the State for the past two years. Twenty-three outfits were operated this past spring. During this season concentrated lime sulfur solution was used in the work, instead of the home-made wash. The prepared solution is much more convenient for this class of work than the home-made, on account of the outfit moving from place to place. Its use reduces the equipment to a barrel pump and accompanying apparatus. The concentrated solution can be carried in the wagon with the spray barrel and water is secured from each place visited. With the outfit a responsible man and helper is able to cover considerable territory. In no case, however, was the sprayer able to complete all the spraying desired in the districts before the opening of buds in the spring. It is planned to commence work with as many public sprayers as possible this fall.

The work has proven of great benefit to the towns and villages where conducted, and its success can be measured by the increasing demand for public sprayers in other parts of the State, and for continuance in those where they have been previously operated. Aside from offering immediate relief to growers for the protection of their trees, the public sprayer demonstrated that there is a demand for this business, and that such spraying can be conducted upon a reasonably profitable basis.

This department conducts the work upon a basis of cost of operation, and not with any desire to make a profit. It is pleasing to note that since the inauguration of the work by this department, several private parties have undertaken to conduct public sprayers in different parts of the State. At least eight private rigs were operated the past season. It is hoped that others will realize the opportunity for remunerative employment from the proper operation of such a business.

The necessity of treatment and the benefits derived from spraying are being appreciated more and more every year. It must be considered as routine for the proper care of many of our common crops. The opportunity for a successful business in the operation of public sprayers is open to any diligent worker.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 141. JANUARY, 1910.

CORN

Variety Tests, Seed Breeding, Selection and Testing.

By C. W. Nash*.

INTRODUCTION.

The average acreage of corn in Maryland for the ten years 1898-1908 according to the Yearbooks of Agriculture is greater than that of any other crop excepting wheat. The following figures show the comparative acreage, production and value of these two leading crops.

Crop	Acreage.	Production.	Value.	Value per acre.	Av. Yield per acre bu.
Corn	...625,711	20,666,893	$10,373,919	$16.45	32.94
Wheat	..781,153	12,419,973	10,094,332	12.93	15. 9

While the acreage of wheat is considerably greater, the total value of crops are nearly equal and the value per acre is considerably greater for corn than for wheat. This value does not take into consideration the value of the corn stover and wheat straw and since in Maryland the corn stover is of greater value than the wheat straw, the actual difference in value per acre is greater than that shown by the above figures.

VARIETY TESTS OF CORN.

The yield of corn greatly depends on the variety of corn used. In order that the farmers of the State may know which varieties yield the most and are best adapted to their conditions, the Station is conducting variety tests on the Station farm and in different parts of the State. Variety test of corn, reported in this bulletin, have been carried on at the Maryland Experiment Station for the last six years, from 1903 to 1908 inclusive.

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*C. W. Nash, B. S., was Assistant Agronomist of this Station from November, 1905 to September 1909, when he resigned to accept a similiar position with the Kansas Agricultural College.

TABLE I.—AVERAGE YIELD OF VARIETIES AT HUSKING TIME—1903 TO 1907.

Record No.	Variety	Source of Seed	Average yield per acre: Bushels of Ear Corn, 70 lbs. 1903-07	Rank 03-07	1904-07	Rank 04-07	1905-07	Rank 05-07	Stover lbs 1905-07	Unmerchantable Corn 05-06
										bu.
21	Cocke's Prolific	U. S. Dep't. Agrl.	63.06	1	68.60	2	70.40	2	5982	2.71
17	Selection No. 77	" " "	58.90	2	63.65	3	62.72	4	3548	1.93
15	Boone Co., Wh. (Ind)	" " "	57.62	3	63.13	4	61.75	6	3716	2.83
14	Boone Co., Wh. (Tenn)	" " "	55.21	4	58.50	5	54.69	12	3707	2.73
23	Mosby's Prolific	" " "	54.32	5	57.45	8	54.21	13	3270	4.09
18	Sanders Improved	" " "	54.02	6	57.29	9	57.03	9	5973	3.36
10	Leaming	" " "	53.29	7	57.56	6	55.51	11	2388	3.31
12	Riley's Favorite	" " "	49.03	8	52.29	10	48.60	16	2539	2.34
11	Reid's Yel. Dent	" " "	48.94	9	51.78	11	51.29	14	2494	2.62
13	Iowa Silver Mine	" " "	45.24	10	46.49	13	44.96	17	2351	3.52
152	St. Omer White	Harford Co., Md.	....	......	70.36	1	72.40	1	4109	2.81
16	Boone Co., Wh. (Special)	U. S. Dep't Agrl.	....	......	57.49	7	58.20	8	3270	2.82
20	McMackins Gourd Seed	" " "	....	......	51.64	12	50.40	15	4884	2.53
3	Munnikhuysen	M. A. E. S.	....	......	....	......	67.27	3	3651	2.83
148	Williams	Carroll Co., Md.	....	......	....	......	61.91	5	3822	3.72
22	Marlboro Prolific	U. S. Dep't Agrl.	....	......	....	......	58.91	7	4723	3.24
19	Hickory King	" " "	....	......	....	......	56.29	10	5156	1.80

TABLE II—AVERAGE YIELD FOR TWO YEARS OF VARIETIES OF CORN TESTED 1907 AND 1908, AT MARYLAND AGRICULTURAL EXPERIMENT STATION.

Recood Number.	VARIETY.	Yield Per Acre.				Ear Corn.						
		Ear Corn at 70 Lbs. Per Bushel.		Shelled Corn Air Dry.	Stover 41% Moisture Pounds.	Per Cent Shrinkage When Air Dry.	Per Cent Shelled Corn When Air Dry.	Per Cent of Moisture.		Chemical Analyses in 1908, on Dry Matter Basis.		
		At Husking Time.	Air Dry 15% Moisture.					In Cob.	*In Shelled Corn.	Per Cent of Protein.	Per Cent of Fat.	Per Cent of Ash.
152	St. Omer	74.85	52 13	52 24	4233	29.39	80.04	38.2	26.36	8.73	4.57	1.35
142	Kemp	65 92	60.02	49.76	3358	23.22	80.23	35.16	22.70	8.77	5.83	1.26
3	Munnikhuysen	64 70	48.20	48.93	3566	23.88	81.28	35.16	23 14	9.64	5.14	1.25
8	McAuley	68.73	46.92	48.49	3848	30.81	82.67	41.32	27.82	9.21	2.67	1.24
151	Coffin	54.90	46 46	47.95	3108	20 13	82.82	30.88	21.74	9 03	4.80	1.19
17	U. S. P. B. Sel. No. 77	60.46	45.24	47.33	2940	24.02	83.52	30.16	22.91	8.75	4.09	1.23
5	Royston	51.66	43.59	45.45	2683	22.21	83.58	35.53	23 47	9.26	5.26	1.24
4	Excelsior	59.59	43.47	44.64	3483	26.24	82.15	35.22	24 71	8.94	4.95	1.50
1	Leaming	55 35	43.15	45.24	3545	21.30	84.30	30.96	21.91	9.25	4.56	1.36

*At the time the corn was shelled, February, 1907, and December, 1908.

TABLE III.—YIELD OF VARIETIES OF CORN, 1907, AT MARYLAND AGRICULTURAL EXPERIMENT STATION.

Record No.	Variety.	Source of Seed.	Rank in air dry Shelled Corn.	Ear Corn 70 lbs. per bus.			Shelled Corn 56 lb. per bus.		Per Cent. of Shrinkage in Ear Corn.		Per Cent. of Moisture in February.		Per Cent. Shelled Corn.		Yield per acre Stover Lbs.	
				At Husking Time.	In February.	Air Dry 15% Moisture.	In February.	Air Dry.	By February.	When Air Dry.	In Cob.	In Shelled Corn.	Feb.	Air Dry.	Weight Dec. 31.	Weight with 40% Moisture.
4	Excelsior	W. O. Collier, Talbot Co.,	12	65.48	52.21	45 41	51.76	46.40	20.4	30.92	32 3	23.83	79.3	81.68	3,851	3,815
142	Kemp	D. C Kemp, Frederick Co	6	73.93	61.89	54.26	57.07	51.97	16,3	26.84	34,14	22.84	74.4	77.34	3,381	3,496
151	Coffin	C. E. Coffin, Prince George's	1	67.16	61.38	57.43	62.50	58.87	14.6	20.99	26.4	20.15	81.0	82.17	3,018	3,873
148	Williams	R. J. Williams, Carroll Co.	17	56.42	45.89	41.60	46,12	41.38	16.7	26.13	30.6	23 02	78.5	80.23	3,511	3,446
5	Royston	W. I. Walker, Queen Anne	9	64.39	53.45	48.41	54,67	49.86	14.4	22.79	30.38	21.68	81.0	82.68	3,976	2,859
11	Reid's Yellow Dent	U. S. Departmnet of Agr.	22	45 34	37.91	35 34	39.91	37.05	15.4	21.68	27.68	19.93	82.7	81.10	2,351	2,855
12	Riley's Favorite	U. S. Department of Agr.	18	47.57	41.59	38.42	44 49	41,07	12.6	18.20	27 71	19.10	84.2	85.62	2,640	3,154
1	Leaming	M. A. E. S.	7	64.06	53.57	48.55	54.72	50 90	17.4	23.52	27 93	19.86	82.6	84.05	3,192	4,068
10	Leaming	U. S Department of Agr.	5	63,52	54.98	51.07	56.51	52.81	12.8	18.84	27.27	19.90	82-1	83.06	2,831	3,060
13	Silver Mine	U. S. Department of Agr.	21	44.91	37,52	35 19	39,26	37.12	16.0	20.28	26.08	19.12	83.5	84.60	2,306	2,422
14	Boone Co. Wh. (Tenn.)	U. S. Department of Agr.	24	46.85	36 81	31,06	35.89	31.33	19.3	30.91	35.68	24.96	78.8	81.32	3,343	3,452
15	Boone Co. Wh. (Ind.)	U. S. Department of Agr.	11	65.65	53.08	47.10	52.22	48.22	17.6	26 43	33.84	21.70	79.5	82.12	3,987	4,245
16	Boone Co. Special.	U. S. Department of Agr.	13	61.58	49 14	43.68	50 14	46.01	18.3	27 06	31,76	22.53	82.5	84.30	4,035	3,394
3	Munnikhuysen	M. A. E. S.	3	74.05	59.36	53.76	58.40	54 42	18.3	26.02	29.04	21.75	79.7	81.04	3,952	4,015
145	Munnikhuysen	M. A. E. S.	15	57.39	46 85	42.14	46 46	43.13	16.6	25.10	29.11	22.30	80.3	81.70	3,617	2,901
8	McAuley	Kansas Experiment Station	4	77.68	60.18	52,08	59-23	53 33	21.5	32,33	35.3	24 43	79.3	81 70	4,586	3,607
152	St. Omer White	G. P. Radebaugh, Harford Co.	2	86.16	66.64	58.04	64 22	58 08	22.0	32.26	33.8	24.04	77.3	79.76	5,081	4,495
17	U. S. P. B, Sel. 77	U. S. Department of Agr.	10	66.12	51.29	46 37	52 49	48 24	21.3	29,40	26.64	23.06	82.2	82.86	3,403	24,51
19	Hickory King	U. S. Department of Agr.	14	64.39	47.67	41.89	49.00	44.08	22.6	32.90	32.14	25.13	82.4	83 78	5,541	3,383
18	Sander's Improved	U. S. Department of Agr.	23	52.87	40.72	33.71	41.28	34.84	26.7	41.44	35.18	31.36	80.8	81.72	4,815	5,031
21	Cocke's Prolific	U. S. Department of Agr.	8	76.90	62.41	50.58	50,20	49,94	19.7	36,32	36.42	31 36	76.4	77.76	6,728	6,306
23	Mosby's Prolific	U. S. Department of Agr.	19	58.98	45.55	36.83	46,48	38.60	25.7	41.46	39.64	31.60	81.9	83.71	7,487	5,189
22	Marlboro Prolific	U. S. Department of Agr.	16	59.07	49.18	40.52	48.95	41.50	19.4	34.43	37.48	29.19	79.5	81.51	4,923	4,918
20	McMackin Gourd Seed	U. S. Department of Agr.	20	55.38	47,10	37.04	43.23	37.43	25.6	37,38	35.63	27.06	78.7	80.2	3,797	4,348

TABLE IV.—YIELD OF VARIETIES OF CORN, 1908, AT MARYLAND AGRICULTURAL EXPERIMENTAL STATION.

Record Number.	VARIETY.	SOURCE OF SEED.	Rank in Shelled Corn (Air Dry.)	Yield Per Acre. Ear Corn at 70 Lbs. Per Bushel		Yield Per Acre.	Per Cent. Shrinkage When Air Dry.	Per Cent. Shelled Corn (Air Dry.)	Per Cent. of Moisture at Time of Shelling.		Yield Per Acre of Stover lbs.	
				At Husking Time.	Air Dry 15% Moisture.	Shelled Corn (Air Dry) in bu.			In Cob.	Shelled Corn.	At Husking Time.	Air Dry 40% Moisture.
17	U.S.B.P. Sel. No.77	U. S. Dept. of Agriculture	2	54.79	44.11	46.41	18.64	84.18	33.67	22.75	2938	3428
202	Boone Co. White ..	W. B. Harris, Kent Co.........	9	53.45	40.23	41.46	23.62	82.45	39.69	24.62	3740	3759
207	Boone Co. White ..	Kansas Exp. Station............	10	49.92	39.28	41.46	20.28	84.45	41.21	23.84	2969	2606
8	McAuley	Kansas Exp. Station............	6	59.78	41.76	43 66	29.28	83.63	47.34	31.20	4410	4088
152	St. Omer White ..	G. P. Radebaugh, Harford Co	3	63.53	46.22	46.40	26 52	80.31	42.60	28 68	3829	3970
4	Excelsior..........	W. O. Collier, Talbott Co.......	8	53 [illegible]0	41 52	42.89	21.56	82.62	38.10	25.59	3719	3150
3	Munnikhuysen.....	Md. Agricultural Exp. Station..	7	55.35	42.61	43.45	21.74	81 52	41.28	24.52	3306	3116
142	Kemp	D. C. Kemp, Frederick Co......	1	57.90	45.77	47.55	19.60	83.11	36.17	22.56	3193	3220
216	Campbell	G. M. Campbell, Cecil Co.......	16	42.78	34.15	35.96	18 20	84.24	33.61	23.10	2674	2634
203	Hildreth	Kansas Exp. Station............	17	53.65	34.50	34.61	33.88	80.26	46.71	33.29	6389	5797
204	Kansas Sunflower .	Kansas Exp. Station...........	12	49.83	37 64	40.09	23.19	85.21	40.92	24.80	4072	4029
206	Legal Tender......	Kansas Exp. Station...........	15	45 16	35.58	36 94	20.62	83.05	35.67	23 99	3985	4288
205	Reid's Yellow Dent	U. S. Dept. of Agriculture	5	51 69	41.96	44.76	18.98	85.34	35.96	23.33	3162	3563
5	Royston	W. I. Walker, Queen Anne's Co.	11	48.92	38.77	40 94	21.62	84.48	40.67	25.26	3395	2507
6	Round Top Dent...	W. I. Walker. Queen Anne's Co.	4	58.48	45.22	46 11	24.14	81.59	42 81	26.35	3953	3676
151	Coffin	C. E. Coffin, Prince George's Co.	14	42.63	35 49	37.03	19.27	83.46	35 35	23.32	2871	2943
2	Leaming	W. I. Walker, Queen Anne's Co.	......	43.21	35.06	36.68	21 32	83 69	33.01	24.63	3072	3326
...	Leaming	Funk Bros. Seed Co............	......	44.65	36.18	37.38	21.23	82.65	28.83	24.33	2996	3316
1	Leaming	Md. Agricultural Exp. Station.	13	46.64	37 74	39 89	19.07	84.55	33.93	23.96	2769	3022

TABLE V.—VARIETY TEST OF CORN ON W. B. HARRIS' FARM, WORTON, KENT CO., MD., IN 1908.

VARIETY.	SOURCE OF SEED.	Average Number of Stalks per Row.	Average Yield of Corn per Stalk, Lbs.	Yield per Acre of Ear Corn, at 70 Lbs. per Bu. at Husking Time.
Boone Co. White..........	W. B. Harris..........	293	.623	40.15
Munnikhuysen.............	Md. Agr. Exp. Sta....	281	.566	34 98
Excelsior..................	Talbott Co............	255	.556	31.17
Leaming..................	Md. Agr. Exp. Sta....	257	.506	28 60

TABLE IX.—YIELD OF VARIETIES OF CORN TESTED ON W. OSCAR COLLIER'S FARM, EASTON, TALBOT CO., MD., 1907 AND 1908.

VARIETY.	SOURCE OF SEED.	Bushels Per Acre.		
		1907x	1908y	Avera e 1907-08
Excelsior.............	W. O. Collier..........	48 0	45.47	46.74
U. S. P. B. Sel. No. 77.	Dept. of Agriculture..	43 9	49.12	46.51
Munnikhuysen..........	M. A. E. S............	44.1	48.69	46.40
Boone Co. White.......	Dept. of Agr., in 1907 / W. B. Harris, in 1908	41.0	46.72	43.86
Royston................	W. I. Walker.........	42.8	42.58	42.19
Leaming (M. A. E. S.).	M. A. E. S............	33.3	37.21	35.26
Shenandoah Yellow.....	....	31.2	27.23	29.22

(x) Ear corn at 70 lbs. per bushel.
(y) Shelled corn, air dry.

TABLE VI.—Test of Corn on Chas. E. Bryan's Farm, Havre de Grace, Harford Co., Md., 1908.

Variety.	Source of Seed.	Per Cent. Shrinkage of Corn from Husking Time to April 10.	Per Cent. Shelled Corn.	Yield of Corn Per Acre.			Rank in Yield.		
				On Ear, 70 lbs. per bu.				April 10 Weight.	
				Husking Time Weight.	Air Dry Wght. April 10.	Shelled April 10.	On Ear at Husking Time.	On Ear.	Shelled.
St. Omer	G. P. Radebaugh, Harford Co.	11.43	83.87	86.46	76.53	80.24	2	1	1
Munnikhuysen	Md. Agricultural Exp. Station	14.29	83.33	87.46	75.63	78.93	1	2	2
Boone Co. White	W. B. Harris, Kent Co	10.00	85.71	81.02	73.22	78.50	3	3	3
Excelsior	W. O. Collier, Talbott Co.	12.29	85.99	79.56	70.19	75.49	4	4	4
Campbell	Geo. M. Campbell, Cecil Co.	8.57	87.50	74.53	67.53	73.72	5	5	5
Coffin	C. E. Coffin, Prince George's Co.	8.29	84.74	69.56	63.93	67.77	9	6	6
Royston	W. I. Walker, Queen Anne's Co.	12.86	85.90	72.57	62.87	67.57	6	7	7
Leaming No. 1	Md. Agricultural Exp. Station	12.86	85.90	70.04	61.54	66.12	8	9	8
Round Top Dent	W. I. Walker, Queen Anne's Co.	14.29	83.33	72.04	61.82	64.42	7	8	9
Cocke's Prolific	U. S. Dept. of Agriculture	11.43	84.84	68.05	60.14	63.83	10	10	10
Reid's Yellow Dent	U. S. Dept. of Agriculture	11.43	86.45	64.05	56.32	60.87	12	11	11
Golden Beauty	U. S. Dept. of Agriculture	14.86	83.22	67.41	56.87	59.04	11	12	12
Leaming	Ohio	7.52	86.30	58.93	54.41	58.67	13	13	13

TABLE VII.—VARIETY TEST OF CORN ON GEO. M. CAMPBELL'S FARM, IRONHILL, CECIL COUNTY, MD., IN 1907 AND 1908.

VARIETY.	SOURCE OF SEED.	Shrinkage of corn from husking time until Air dry.		Per cent. of shelled corn air dry.		Yield of corn per acre, air dry. On ear, 70 lbs. per bus.		Shelled.		Average for two years.	
		1907	1908	1907	1908	1907	1908	1907	1908	On ear	Shelled.
Campbell's	Geo. M. Campbell	......	18.42	......	86.5	......	58.73	......	63.50	....	....
Royston	W. I. Walker, Queen Ann Co.	22.32	16.40	82.4	85.9	54.39	52.84	56.01	56.74	53.62	56.38
Boone Co. Wh.	W. B. Harris, Kent Co.	......	21.67	......	86.4	......	53.62	......	57.91	53.74	56.15
BooneCo. W(Tenn.)	U. S. Department Agriculture	22.54	......	80.8	......	53.85	......	54.39	......	....	....
Excelsior	W. O. Collier, Talbott Co.	23.00	16.77	81.3	84.2	50.69	53.08	51.51	55.87	51.89	53.69
Munnikhuysen	Md. Agrl. Experiment Station	23.62	19.86	74.3	83.1	55.42	49.82	54.93	51.75	52.62	53.34
U.S.P.B. Sel. No. 77	U. S. Department Agriculture	19.64	......	830	......	53.73	......	55.74	......	....	....
Leaming	Md. Agrl. Experiment Station	23.53	19.47	837	85.7	52.28	36.35	54.70	38.94	44.32	46.82

TABLE VIII. VARIETY TEST OF CORN ON EDWARD S. CHOATES' FARM, ROSLYN, BALTIMORE CO., MD., IN 1907 AND 1908.

VARIETY.	SOURCE.	Yield per acre on ear at husking time, 70 pound per bushel. 1907.	1908.	Average for two years.
Munnikhuysen	Md. Agr. Exp. Sta	77.44	77.52	77.35
Excelsior	W.O. Collins, Talbott Co.	68.04	71.76	64.31
Leaming	Md. Agr. Exp. Sta	61.24	66.44	55.84
Boone Co. Wh. (Tenn)	U. S. Dept. of Agr.	....	....	47.45
U. S. P. B. Sel. No. 77	U. S. Dept. of Agr.	....	....	55.15
Edw. Choates	Local	....	....	72.62
Pierce Choates	Local	....	....	72.78
Harmor Khlor	Local	....	....	69.95
Leaming	Edw. S. Choates from M.A.E.S. the yr. before.	....	69.32	....
Carroll Co. Yel	Carroll Co.	....	68.22	....
Albert Luttgirding	Local	....	83.94	....
St. Omer	Harford Co.	....	83.28	....

TABLE X—VARIETY TEST ON W. OSCAR COLLIER'S FARM, EASTON, TALBOT CO., MD., IN 1907.

Variety.	Source of seed.	Average Heighth in Feet		Per Cent Stalks Barren.	Yield per A. of Ear Corn at Husking time. at 70 lbs. per bu.
		of Stalk.	to Top Ear.		
Excelsior	W. O. Collier	10	5	10	48.0
Imp. Md. Wh. Dent	G. & Turner	9	4½	12	45.4
Cooper Corn No. 5	R. F. Cooper, Easton	10¾	5½	10	44.9
Munnikhuysen	M. A. E. S. No. 3	9¾	4¾	9	44.1
U. S. P. B. Sel. 77	U. S. D. A	9¾	4½	8	43.9
Warner No. 8	H. W. Warner, Easton	10½	5¼	7	43.7
Royston	W. I. Walker	9¼	4¼	10	42.8
Kemp	D. C. Kemp	10	5	15	42.0
Best Twins	G. & Turner	9	4½	10	41.6
Iowa Silver Mine	Iowa Seed Co	9	4½	10	41.1
Boone Co White	Tenn. (M. A. E. S.)	10	4¾	10	41.0
Imp. Golden Beauty	G. & Turner	10	5	8	41.0
Chestnut Grove Yel	G. & Turner	9½	4¾	7	39.3
Diamond Joe Big White	Ratekin Seed House	9¾	4½	10	37.4
G. & Turner 90 Days	G. & Turner	9.3	4.2	8	34.7
Leaming	M. A. E. S. No. 1	9	4	15	33.3
Shenandoah Yel	Fields	10	5	5	31.2
Golden West	Iowa Seed Co	9¼	4¼	15	29.8
Reid's Yel. Dent	Fields	9.1	4.4	7	29.3
Pride of Wishma	Ratekin's Seed House	8.7	4	7	23.0
Imp. Leaming	Iowa	8	3¾	25	21.8

TABLE XI.—VARIETY TEST OF CORN ON W. OSCAR COLLIER'S FARM, EASTON, TALBOT CO., MD., IN 1908.

Variety.	Source of Seed.	Height of Stalk.—Feet.	Date Ready to Cut.	Days to Mature.	Shrinkage of Corn from Husking Time to April 8.	Per Cent. Shelled Corn.	Yield of Corn Per Acre. 70 Lbs. of Ear Corn Per Bushel. Husking Weight.	Yield of Corn Per Acre. 70 Lbs. of Ear Corn Per Bushel. Air Dry April 8.	Yield of Corn Per Acre. Shelled Corn April 8.	Rank in Yield. On Ear at Husking Time.	Rank in Yield. April 8. On Ear.	Rank in Yield. April 8. Shelled.
U. S. P B. Sel. No. 77.	Dept. of Agriculture....	8	9–20	122	3.43%	87.28	46.6	45.09	49.12	3	2	1
Munnikhuysen.... ...	M. A. E. S..............	7½	9–18	120	4.00%	82.44	48.9	46.94	48.69	1	1	2
Boone Co. Wh.... ..	W. B. Harris.	7½	9–20	122	4.86%	85.59	45.9	43.69	46.72	4	4	3
Round Top Dent.	W. I. Walker...........	7	9–19	121	3.15%	83.21	47.2	44.02	46.02	2	3	4
Excelsior..............	W. O. Collier............	8	9–19	121	3.71%	85.46	44.2	42.58	45.47	5	5	5
St. Omer...............	G. P. Radebaugh........	8¼	9–22	124	3.71%	83.09	42.9	41.45	42.92	6	6	6
Royston................	W. I. Walker...........	6½	9–18	120	4.29%	85.07	41.8	40.06	42.58	7	7	7
Selection No. 12........	W. O. Collier............	7¼	9–15	117	4.29%	84.18	40.3	38.56	40.54	9	8	8
			(Immat ure at)									
Cornplanter..........	....	7½	9–22	124	8.57%	84.38	40.6	36.80	38.72	8	9	9
Haxall..............	....	8¼	9–22	124	6.57%	84.10	38.6	36.06	37.84	10	10	10
Leaming	M. A. E. S..........	7	9–25	117	3.43%	85.[illegible]0	35.9	34.71	37.21	12	11	11
Selection No. 15........	W. O. Collier............	7¾	9–22	124	5.71%	83.94	37.3	35.24	36.86	11	12	12
Coffin	C. E. Coffin.............	7	9–14	116	4.29%	85.07	31.7	30.43	32.32	13	13	13
Selection No. 14.......	W. O. Collier.......	7½	9–20	122	6.29%	84.15	27.8	25.99	27.23	14	14	14

TABLE XII.—Tabular Description of Varieties of Corn Tested at the Maryland Agricultural Experiment Station—1907 and 1908.

Record No.	Variety of Corn.	Average Height in Feet. Of Stalk. 1907	Of Stalk. 1908	To Top Ear. 1907	To Top Ear. 1908	Per Cent. of Stalks. Barren. 1907	Barren. 1908	With 2 or more ears. 1907	With 2 or more ears. 1908	With Suckers. 1907	With Suckers. 1908	Average weight of merchantable ears huskiug time. 1907	1908	Number of days to mature. 1905-'06	1908
4	Excelsior	10.2	9.5	5.2	4.5	8	17.3	1.5	0	6	1.4	.94	.64	128	128
142	Kemp	11	9.4	5	4	10	16.2	2	0	5	2	.83	.57	....	127
157	Coffin	10	8.5	4.5	3.5	17	12.9	1	....	11	0	.78	.56	....	123
148	William	10	....	4	....	15	....	1	0	6	....	.84	1.29	....	....
5	Royston	10	8.8	4	3.6	15	15.1	1	4	9	....	.77	.56	....	116
11	Reid's Yellow Dent	10.5	9	4.5	3.7	5	11.2	3	0	17	9	.79	.62	124	126
12	Riley's Favorite	10	....	4	....	10	....	2	....	7	....	.68	....	118	....
1	Leaming	9.5	8.5	4	3.6	10	12.5	2	.3	3	2.3	.80	.57	114	126
10	Leaming	9.5	....	4	....	6	....	.4	....	13	....	.70	....	....	....
13	Iowa Silver mine	9	....	4	....	8	....	1	....	9	....	.70	....	118	....
14	Boone Co. White	10.5	8.7	4.5	4	9	14.2	3	.5	3	8.8	.80	.68	130	128
15	Boone Co. White	10	....	4.5	....	10	....	4	....	4	....	.81	....	....	....
16	Boone Co. Special	9.5	....	4	....	7	....	5	....	3	....	.81	....	125	....
3	Munnikhuysen	10.2	9.1	5	3.7	10	14	2	....	10	2.6	.74	.63	127	128
145	Munnikhuysen	10.2	....	4.5	....	7	....	4	0	9	....	.82	....	....	....
8	McAuley	9.5	8.8	4.2	4.3	7	16	4	0	14	3.3	.79	.73	....	132
152	St. Omer White	10	9.6	4.5	4.2	7	8.7	.5	0	8	1.7	1.05	.68	130	128
17	U. S. P. B. Sel. No. 77	10	7.8	4.5	3.4	5	6.9	2	0	6	5	1.04	.60	131	127
19	Hickory King	9.5	....	4.5	....	3	....	8	....	7	....	.75	....	80% ripe 134 days	....
18	Sander's Improved	10	....	5	....	7	....	14	....	8	....	.74	....	24% ripe 134 days	....
21	Cocke's Prolific	11	....	5.5	....	3	....	30	....	16	....	.74	....	54% ripe 134 days	....
23	Mosby's Prolific	10.5	....	5.5	....	8	....	11	....	21	....	.62	....	21% ripe 134 days	....
22	Marlboro Proiific	10.2	....	5.2	....	7	....	30	....	23	....	.64	....	48% ripe 134 days	....
20	McMackin's Gourd Seed	10.7	....	5.5	....	9	....	16	....	3	....	.87	....	36% ripe 134 days	....
216	Campbell	9.2	9.2	....	3.7	....	20.2	....	0	....	2.4	....	.59	....	127
203	Hlldreth	10	10	....	4.5	....	17.7	....	.4	....	4.3	....	.70	....	127
204	Kansas Sunflower	9.4	9.4	....	4.	....	12.7	....	0	....	3	....	.56	....	133
206	Legal Tender	9	9	....	3.7	....	12.7	....	0	....	17.	....	.64	....	130
6	Round Top Dent	9.1	9.1	....	3.8	....	12.5	....	0	....	4	....	.65	....	124

TABLE XIII.—CHEMICAL ANALYSIS ON AIR DRY BASIS OF 1908 SEED AND CROP.*

Record Number.	NAME OF VARIETY.	SOURCE OF SEED.	Of Seed Used.			Of Crop Grown.		
			Per Ct. Nitrogen.	Per Ct. Fat.	Per Ct. Ash.	Per Ct. Nitrogen.	Per Ct. Fat.	Per Ct. Ash.
17	U. S. B. P. Selection No. 77.	U. S. Dept. of Agriculture ...	8.09	5.38	1.67	8.75	4.09	1.23
202	Boone Co. White............	W. B. Harris, Kent Co	9.08	5.35	1.62	8.47	4.97	1.34
207	Boone Co. White............	Kansas Exp. Station..........	9.87	5.55	1.73	8.84	4.93	1.64
8	McAuley....................	Kansas Exp. Station..........	9.08	5.08	1.48	9.21	3 67	1.24
152	St. Omer White	G. P. Radebaugh, Harford Co.	8.13	5.20	1.62	8.73	4.57	1.35
4	Excelsior..................	W. Oscar Collier, Talbott Co..	9.13	4.47	1.44	8 94	4.95	1.50
3	Munnikhuysen	Md. Agricultural Exp. Sta....	7.57	5.61	1.51	9.64	5.14	1.25
142	Kemp.......................	D. C. Kemp, Frederick Co....	9.60	5.62	1.38	8.77	5.83	1.26
216	Campbell...................	G. M. Campbell, Cecil Co.	8.07	5.56	1.56	9.57	5.14	1.38
203	Hildreth...................	Kansas Exp. Station..........	9.16	5.20	1.60	9.15	4.77	1.47
204	Kansas Sunflower...........	Kansas Exp. Station..........	10.15	5.21	1.36	9.16	4.64	1.21
206	Legal Tender...............	Kansas Exp. Station..........	10.06	4.47	1.42	9.26	4.13	1.52
205	Reid's Yellow Dent.........	U. S. Dept. of Agriculture ...	9.78	5.25	1.54	8.83	5.19	1.22
5	Royston....................	W. I. Walker, Q. Anne's Co..	8.19	5.54	1.36	9.26	5.26	1.24
6	Round Top Dent.............	W. I. Walker, Q. Anne's Co..	9.14	5.56	1.63	8.93	5.18	1.24
151	Coffin.....................	C. E. Coffin, Pr. George's Co.	9.19	5.56	1.53	9.03	4.80	1.19
2	Leaming....................	W. I. Walker, Q. Anne's Co..	7.99	5.08	1.63	8.80	4.85	1.35
....	Leaming....................	Funk Bros.' Seed Co., Illinois.	9.23	4.95	1.51	8.61	4.88	1.53
....	Leaming....................	Md. Agricultural Exp. Sta....	....	....	....	9.25	4.56	1.36

*Made by L. B. Broughton, Assistant Chemist.

The varieties used the first year were ones recommended by the Department of Agriculture and included several of the standard varieties of the West, and some of the best yielding varieties of the South. Since then other varieties mostly those local to the State have been included in the test and an opportunity is given not only to compare the adaptability of the different standard varieties to our conditions, but also to compare the standard varieties from seed obtained from other States with our local varieties from home grown seed.

The work in 1903 was in field No. 25, and the other years it has been carried on in field No. 13, which was also in corn in 1902 and 1903. The soil is medium heavy and fairly uniform in character. In the springs of 1904, 1906 and 1907 the field was manured. This land was in a medium high state of fertility.

Every year before planting the seed the ground was thoroughly pulverized and put in as good condition as possible for seed germination. The first five years the seed was drilled in with a Hench Dromgold, one row drill set to drop 15 inches apart in the row, but in 1908 the planting was done by hand in hills three feet 9 inches apart in the row. Three kernels per hill were planted in the East two-thirds of the row and four in the West one-third of the row. The rows were three feet nine inches apart and were four hundred and sixty-nine feet long the first four years of the test, two hundred and fourteen feet long in 1907 and four hundred and seventy-two feet long in 1908. The first four years a different variety was planted in each row, and three duplications made. In 1907 each of the varieties were planted in four row plots, in 1908 in two row plots with no duplicate plots either year; but every sixth plot was planted with the same variety and used as a check.

The average date of planting was May 21st, about ten days later than the best time to plant corn on the Station farm. This made the season somewhat short for the prolific varieties of corn but the medium maturing ones ripened, except in 1907 when all except two varieties were immature at the time of the first heavy frost, October 9th.

The first four years of the test the yield of corn was based solely on weight of corn at husking time, the last two years it was based on both husking time, and air dry weights. At the time of husking a sample of about 50 pounds of average ears was saved from each variety and stored in sacks. Later these samples were reweighed, the corn shelled and the percentage of moisture in both cob and shelled corn was determined by use of the drying oven. The air dry weight was figured on the basis of 15 per cent. of moisture.

The stover in 1907 was put into shocks and not weighed until December 31st when even that of the later maturing varieties was quite well dried out. In 1908 it was weighed at the time of husking. Both years at the time of weighing the stover, samples of the stover from each of the varieties were taken to determine the percentage of moisture contained in each.

Two of the local varieties and all of the varieties which were tested

in cooperation with the Department of Agriculture except Selection No. 77 were dropped from the test at the end of the fifth year. Four local strains or varieties, Funk's Leaming and six varieties from the Kansas Station were introduced the sixth year, 1908.

The comparative yields of the different varieties tested at the Station during the years 1903 to 1907 are shown in Table I. These yields are based on the field weight of ear corn at husking time. Had the air dry yield of each variety been ascertained the relative yield would have been considerably different as shown by a comparison of the air dry and husking time weights of the varieties of corn in 1907 and 1908. Table III and IV. The first ten varieties in the table were introduced in the test in 1903 and are placed in order of yield for the five years 1903-1907. The next three varieties were introduced in 1904 and the last four in 1905. The rank in yield, at husking time, of all the varieties for the years 1903-1907 and 1905 to 1907 is shown in the table. The three highest yielding varieties for 1903-1907 are Cocke's Prolific, Selection No. 77 and Boone County White (Indiana). For the years 1904-1907 the order of yield for the four highest yielding varieties is the St. Omer, Cocke's Prolific, Selection No. 77 and Boone County White (Indiana). For the years 1905-1907 the order of yield for the six highest yielding varieties is St. Omer White, Cocke's Prolific, Munnikhuysen, Selection No. 77, Williams and Boone County White (Indiana). In average of yield of stover for the three years 1905-1907 the three highest yielding varieties are the Cocke's Prolific, Sander's Improved and Hickory King. These varieties were immature at time of cutting, and at the time of husking and weighing contained much more moisture in the stover than most of the other varieties, for which fact some allowance must be made in comparing yields of stover.

The comparative yields of the varieties which were in the test both 1907-1908 are shown in Table II. In this table is shown not only the yield of ear corn at husking time but also the yield of ear corn and shelled corn when they are air dry. The varieties are placed in the order of their yield on the air dry basis.

Cooperative variety tests have been carried on with six different farmers in this State. Four of the tests were started in 1907 and two in 1908. Of the four started in 1907 one was not continued in 1908 and the results for the first year are not reported. Table V, page 111, shows the yield of corn on the farm of Walter B. Harris, Worton, Kent, County, for the four varieties tested in 1908. Table VI shows the yield of eleven varieties of corn tested on the farm of Chas. E. Bryan, Havre de Grace, Harford County, in 1908. Table VII shows the yield of the varieties tested on the farm of Geo. M. Campbell, Ironhill, Cecil County, in 1907 and 1908.

Table VIII shows the yield of the varieties tested on the farm of Edward S. Choates, Roslyn, Baltimore County, in 1907 and 1908. Table IX, page 111, shows the average yield of those varieties of corn tested on the farm of W. Oscar Collier, Easton, Talbot County, in 1907

and 1908. Tables X and XI show the yields for each year separately for all the varieties tested at W. Oscar Collier's in 1907 and 1908.

Table XII gives a description of all the varieties grown at the Station 1907-1908.

Table XIII gives the chemical analysis both of the seed planted and of the crop grown in the year of 1908.

The analyses of the seed shows much more variation than that of the crop due likely to the difference of conditions under which the seed of the different varieties were produced. The seed of the Munnikuysen is very low in protein content. This is likely due to the corn in 1907 being raised on a wet heavy soil which did not produce more than about fifteen bushels per acre. In the crop produced, the Munnikhuysen had a higher per cent of protein than any other variety. Other varieties which analized comparatively high are the Royston, Campbell's and the four from the Kansas Station. The average analysis of the high yielding varieties are fully as high as those of the lowest yielding varieties of the test. Of the nine varieties tested both 1907 and 1908 (Table II) the average analysis of the four heaviest yielding varieties, yield based on an air dry shelled corn, was 9.09 per cent. protein, 4.84 per cent. fat and 1.28 per cent. ash, while that of the four lowest yielding varieties is 9.05 per cent. protein, 4.72 per cent. fat and 1.44 ash.

CHOOSING A VARIETY OF CORN.

The main factors to be taken into consideration in choosing a variety of corn for planting are: The yield per acre, the maturity, the uniformity and trueness to type and the color. The relative importance of these points for Maryland conditions, in the opinion of the writer, is shown in the following score card:*

FOR USE IN JUDGING CORN AT HUSKING TIME.

1	Bushel per acre (uniform moisture content)	50
2	Maturity	25
3	Uniformity and trueness to type	15
4	Color	10
		100

The yield of course is first in importance. This, however, should be based on the weight of shelled corn rather than on the weight of ear corn for the proportion of cobs is much greater in some varieties than in others, and the cobs have little commercial value. (See Fig. 1).

The yield should also be based on the same moisture content otherwise if varieties at husking time vary much in the percentage of moisture which they carry the yields would not be comparative. The variation in amount of shrinkage in the variety test at this Station in 1907 (Tables III and IV), was from 18.2 per cent. to 41.46 per cent. and in

*Adopted by the Ohio Corn Improvement Association in 1908.

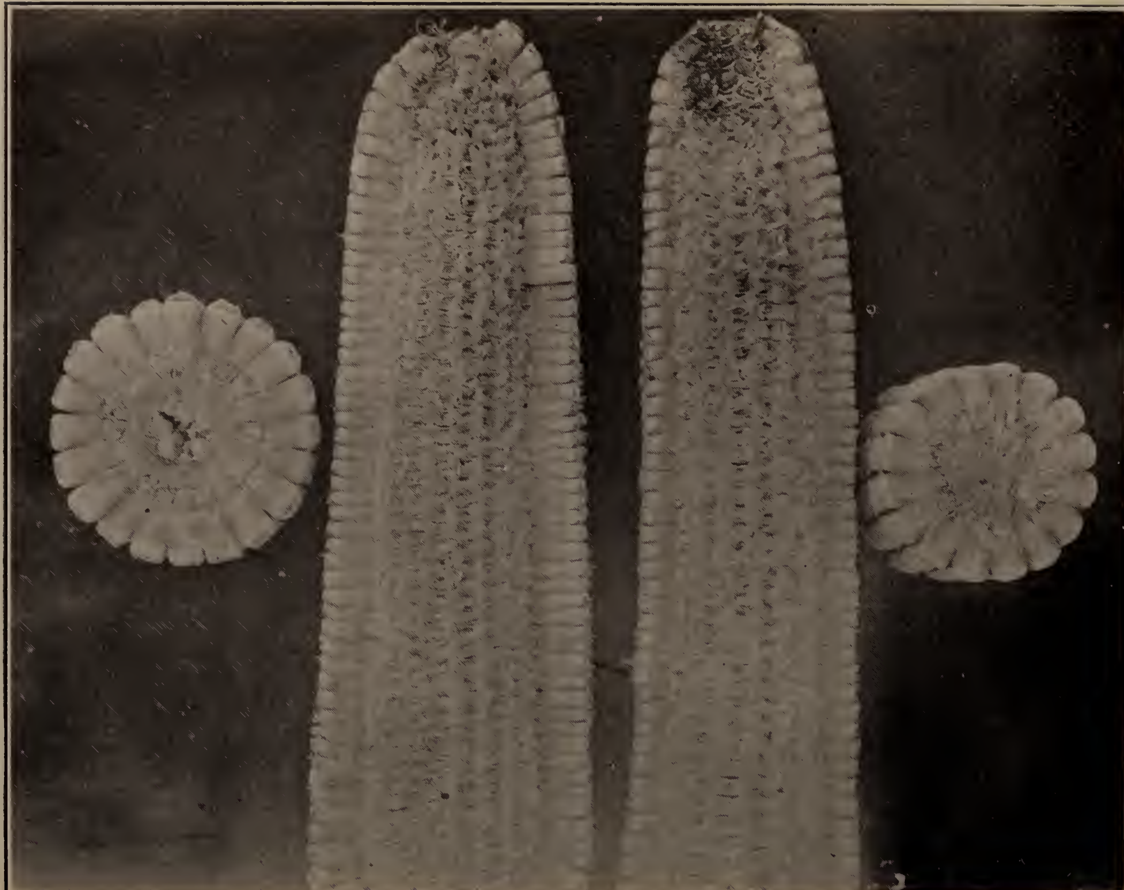


Fig 1.—Ear on left has desirable shaped grain and good proportion of grain to cob for heavy yield. Note the [illegible] of the grain and how they fit against each other. Ear on right has too much cob for the amount of grain.

1908 from 18.2 to 33.88 per cent. If one variety of corn contains 18.2 per cent. moisture and another variety 41.46 per cent. as was the case in the 1907 test, and if the air dry yield of each is fifty bushels per acre, the recorded yields at husking time at seventy pounds per bushel of ear corn would be 61.1 bushels for the first variety and 85.4 bushels for the latter, a difference of 24.3 bushels in favor of the latter when the actual yield of corn was the same.

The variation in yield of different varieties is very great as can be seen from studying the tables of this bulletin. In fact it is so great that farmers should use some means by which to select out the best varieties for their farms. As will be noted some varieties or strains of corn grown in a neighborhood may yield ten to thirty bushels more than other varieties when grown under identical soil fertility and culture condition. It is also possible that there may be a higher yielding corn in some other part of the State, which will yield better than any of the local strains. To find out these things farmers should study the results of variety tests at the Station and if no cooperative variety test has been made in or near his locality he should conduct a variety test including three or more of what he thinks are the best local varieties and three or more varieties that did the best at the Station farm.

It will not pay to include in such a test seed from distant sources for such seed has to be acclimated and be selected for adaptability to conditions before it will be able to compete with home-grown seed. Neither will it pay to introduce into the test, varieties that mature too early or too late. In the variety tests at this Station as shown in Tables I to IV, the highest yielding varieties are among those which were early enough to mature in the average season and late enough to use practically all of the growing season for corn. It is not worth while to try the prolific varieties of corn unless fodder is the principal thing desired, as none of those in the test at this Station equalled in yield the highest yielding one ear to the stalk varieties when the yield was based on air dry weights. They are also too late in maturing for the average season in Maryland. When it becomes necessary to replant the whole field or for some other reason the planting must be late an early maturing variety should be planted.

SELECTION OF SEED.

The variety of corn to plant having been chosen the next step is to select the ears. The first selection is generally made either from the crib or just after husking before cribbing. Selection from the crib is objectionable because the corn is likely to be poor in vitality from lack of proper storage. The selection just after husking before cribbing is much more preferable to selecting from the crib, for then it can be stored in a suitable place for drying out. A still better method for good results is to select the ears from good stalks before husking time. The following score card is a fair guide in the selection of plants.*

*Adopted by the Ohio Corn Improvement Association.

FOR USE IN THE PLANT SELECTION OF CORN.

1	Adaptability	35
2	Vigor	25
3	Height of plant, and height and angle of ear	15
4	Uniformity and trueness to type	10
5	Weight of ear	15
		100

EXPLANATORY NOTES.

1 Adaptability—Plants must be adapted to the average soil conditions and should not mature too late or too early.

2 Vigor—Indications of vigor are uprightness of stalk, a well developed leaf and ear and freedom from disease.

3 Height of Plant and Ear—Avoid extremes in either direction in the case of both plant and ear. The Market condition is favored if tip points downward.

4 Uniformity—The plant and ear should be uniform in manner of growth, height of plant and ear, etc., and conformity to the type determined upon.

5 Weight of Ear—The weight should be estimated and taken into consideration in selecting for high yield.

The vigor of plant and weight of ear is dependent somewhat upon the conditions of growth and a plant which is more favorably located than the other plants should be discarded or an allowance made for its advantage. Many of the large ears found in a pile or in a crib are large because of abnormally favorable conditions of growth. By selecting the corn before husking time these ears are not chosen and hence greater progress is made in the improvement of the corn.

The amount of seed selected in the fall should be at least twice as much as is needed for planting as it is impossible in the rush of fall work to give the selection of ears the attention which it deserves and furthermore even under the most favorable conditions of storage considerable corn must be discarded because of poor vitality.

Corn as soon as selected from the field should be taken to some place where it will have opportunity to dry out. Different methods of drying are in use. One method is to tie fifteen or twenty ears together with binder twine, or other suitable cord, and hang them from the ceiling of a shed or other well ventilated room. If mice are troublesome hanging from wires will prevent injury from them. Another method of storing is to make corn racks by means of upright pieces and frequent shelves on which to lay the ear (See Fig. 2).

At the seed house of this Station instead of shelves, trays or slat drawers in which the corn is placed one ear deep are used. This gives opportunity for air to circulate around each ear and if the room is kept well ventilated for the first month or two to allow the moisture to escape the corn will dry out in good condition.

Fig. 2.—Shelves for Storing Seed Corn.

Those who save large amounts of seed corn can afford to provide a seed room or seed building with heating facilities. The sides of the building should have a large amount of window or door space so that good ventilation may be secured when needed. Heat should be used to dry out the seed in the fall and to dry the air during damp weather to prevent the taking up of additional moisture.

One of the best places to store corn where only a small amount is saved is in an attic over a heated room. The corn should be first allowed to dry in an open shed or other well ventilated place and then before freezing weather sets in it should be placed in the warm room where it will then keep in good condition.

FINAL SELECTION.

In February or March after the corn has become thoroughly dry and is not likely to suffer further injury and before the rush of spring work comes on the second and final selection of the seed should be made. The important points to take into consideration together with their relative importance, in the opinion of the writer, is shown in the following score card.[a]

FOR USE IN THE FINAL SELECTION OF SEED EARS.

1 Adaptability	25
2 Seed condition	15
3 Shape of kernel	15
4 Uniformity and trueness to type	15
5 Weight of ear	10
6 Length and proportion	10
7 Color of grain and cob	5
8 Butts and tips	5
	100

EXPLANATORY NOTES.[b]

1 Adaptability—Of first consideration in the selection of seed corn. Indicated by the filling out of kernels, by ripeness and by the apparent utilization of soil and climate conditions.

2 Seed Condition—Of vast importance, for seed corn that will not grow is worse than worthless. Indicated by solidity of ear and of kernels on the ear; by brightness of color, especially of germ, and by plumpness of tip. While the germination test is the final arbiter, the trained eye can determine much.

3 Shape of Kernel—Kernels should broaden gradually from tip to crown, with edges straight so that they will touch the full length, and should be wedge-shaped without coming to a point. Observed from the edge they should have uniform thickness. Thin, shrunken or sharp-pointed kernels are very objectionable. (See Fig. 3.)

a—Recently adopted by Ohio Corn Improvement Association.
b—Circular, 86, Ohio Exp. Sta.

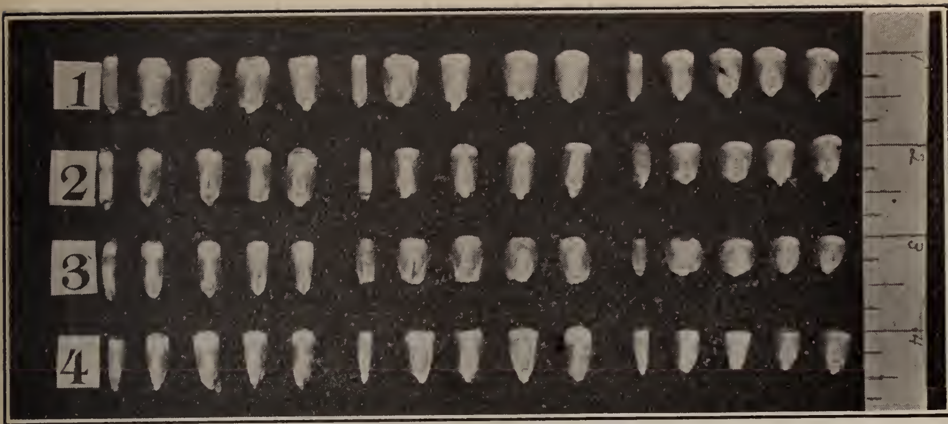


Fig. 3.—Grains of row 1 and 2 from left to right are good shapes for very fertile, medium fertile and poor soil. Row 3 has undesirable shapes. Those for very rich soil being too narrow, those for medium and poor soil, the sides are too much curved causing wide open spaces between the rows. Those of row 4 are too pointed, showing immaturity and weak germ.

1 2 3 4

Fig. 4.—Showing Fairly Good Types of Ears.
Ear 1 is a Little Rough at the Butt. Ear 2 is a Little too Uneven at the Tip.

4 Uniformity and Trueness to Type—The ears selected should be uniform in size, shape, color, indentation and size of kernel. Uniformity or trueness to the type determined upon, is essential. (Fig. 4 and 5.) Uniformity of kernels is essential to machine planting.

5 Weight of Ear—To be determined by the use of scales after the corn is thoroughly air dry. Many seasons this is not practical before January. Where the stand and other conditions of growth are equal, weight of ear is a good indication of productiveness.

6 Length and Proportion—Length will vary according to environment. No standard can be set by the score card save that set by maturity and proportion. The circumference when measured at one-third the distance from butt to tip should not exceed four-fifths nor fall below three-fourths the length.

7 Color of Grain and Cob—Grain should be free from mixture. Uncertain tints in cob and grain, and off-colored kernels are suspicious. White corn should have white cobs and yellow corn should have red cobs.

8 Butts and Tips—Kernels should extend in regular rows over the butt and against the shank. The shank, however, should have sufficient size to support the ear. Swelled, open or badly compressed butts, as well as those having kernels of irregular size, are objectionable. (See Fig. 6).

The tips should have kernels of even size, well dented and preferably in regular rows. An under-sized ear is more objectionable with a completely capped tip than a normal sized one showing some bare cob. A sharply tapering tip is not desirable.

THE RELATION OF EAR CHARACTER TO YIELD.

A study has been made of the results of the variety test of corn and the ear test of corn at the Maryland Experiment Station for the purpose of ascertaining the relation of certain ear characters to yield, the results are not conclusive but are indicative.

In the study of the variety test it was observed that the heaviest yielding varieties are mostly medium large to large eared and are only medium in depth of kernels and proportion of corn to cob. This is well illustrated in Table II in which the highest yielding variety on the air dry basis for the two years had 80 per cent. of grain and the per cent. increases and the yield decreases as one goes down the column. In 1907 the year in which more varieties were tested than in any other year the yield and percentage of grain in the twelve highest yielding varieties on the air dry basis was 51.92 bushels and 81.35 per cent.

1 2 3 4 5

Fig. 5.—Ears 1, 2 and 3 have bad proportion, and too much open space between the grain. Ears 1 and 2 are too large in circumference for the length. Ear 3 is too long for its circumference. Ears 4 and 5 have good proportion.

Total Weight Air dry.	Weight of Shelled Corn Air dry.	Per Cent. of Shelled Corn.
Ear 1—13.50 oz.	Ear 1—11.00 oz.	Ear 1—81.48
Ear 2—13.00 oz.	Ear 2—10.50 oz.	Ear 2—80.77
Ear 3—13.75 oz.	Ear 3—10.75 oz.	Ear 3—78.18
Ear 4—12.50 oz.	Ear 4—10.50 oz.	Ear 4—84.00
Ear 5—12.75 oz.	Ear 5—10.75 oz.	Ear 5—84.31

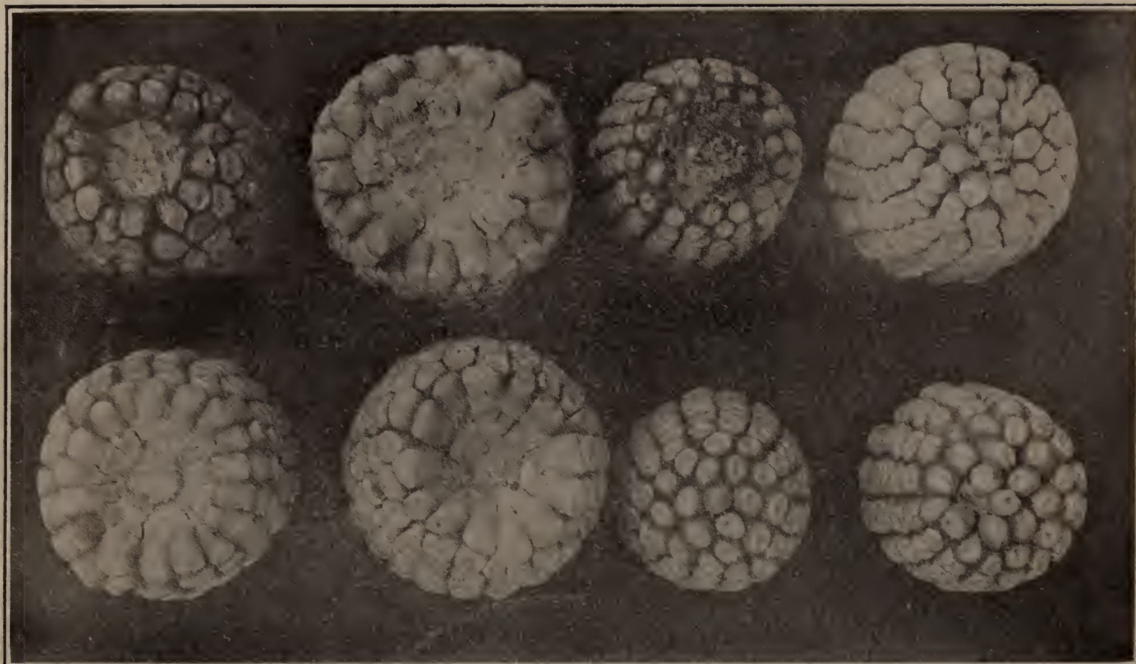


Fig. 6.—Top row—Tips nearly perfectly capped showing complete maturty and growth. Desirable for show ring and large ears, but not so desirable for small ears of a variety. Tip on left buttom row, is more desirable showing complete maturity but is capable of doing more under more favorable conditions as is shown by protruding cob. Tip on left bottom row has too much bare cob.

Butts in top row are well filled and shank is large enough to support large ear. Butt on left in bottom row is too uneven, shank large and hard to break. Butt on right bottom row is a little too compressed, causing a small weak shank.

while that of the twelve lowest yielding varieties is 39.46 bushels and 82.73 per cent.

A comparison was made of the ear-row-tests of Leaming—1904 to 1907 between the five and ten highest yielding ears and the five and ten lowest yielding ears as regards ear characters. The only point on which there was much difference between the highest and lowest yielding ears was in length of grain and proportion of shelled corn. The average difference for the four years on these points was 1-80 inch longer grains and one per cent. more shelled corn in the case of the lowest yielding ears.

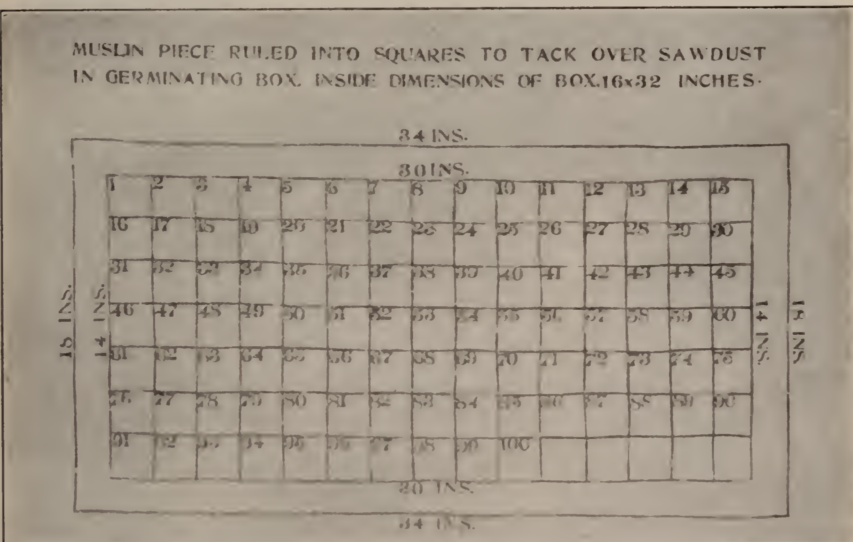


Figure 7.

In 1907 the product of each of the 39 ears of the ear-test was shelled and the percentage of grain determined. The results were compiled into the following table.

Rows in which the per cent. of shelled corn is between	No. of rows represented.	Average yield of rows—lbs.
78 and 79	3	112.2
79 and 80	4	132.1
80 and 81	7	138.3
81 and 82	6	125.0
82 and 83	12	127.5
83.0 and 83.7	7	130.9

The greatest yield was obtained from those ears whose product shelled between 80 and 81 per cent.

In 1908 seed from each of several rows of the Leaming ear test were separated into classes according to depth of grain and finally just 12 ears of each grade, the medium depth grade and the rough deeper grade, were selected for planting in a field test the season of 1908. The grains of the medium depth were 7-16 to 8-16 inches long and the deep were 9-16 to 11-16. The size of the ears was about the same but the deep grain ears were the heaviest by an average of about .06 of a pound per ear. In the yield test the medium deep yielded 40.40 bushels per acre while the deep yielded 37.60 of air dry shelled corn.

In the thirteen ear test plots which have been conducted at the Station and out in the State in cooperation with farmers the length of the short grained varieties has increased from 6-16 or more to about ½ inch in length while those that were over a half inch have decreased in length. The selection was based principally on yield of ears. This is an indication that ½ inch is about the right depth of grain.

The study indicates that it is disadvantageous to have kernels over ½ inch long and a percentage of shelled corn of more than 81 or 82 per cent. and that medium large to large ears are associated with high yield.

TESTING FOR GERMINATION.

One of the important things in increasing the yield of corn is to test each ear to be used as seed. This should be done before the rush of spring work so that it will not be neglected. The value of testing is fully realized by all who have made tests. It is rarely in the corn which we receive at this Station and which we save for seed, that less than twenty-five per cent. of the ears are discarded because of poor germination as shown by the germination test. And a large per cent. of the ears that will not grow are ears that appear to be good in vitality.

In the spring of 1906 one of the best corn growers in this State and the writer picked out fifty of the best ears of corn of a certain variety that he had stored for seed to be tested and the ears of good germination to be used for planting his ear-row test for that year. In the germination test only thirteen of the fifty ears showed good vitality. Most of these ears from outside appearances were good and not more than ten or possibly fifteen ears would have been discarded by ordinary close inspection even when the grains were examined.

A very practical method of testing, one that has been used by this Station for several years, is to use a germination box and sawdust. The box is easily made and any box about six inches deep may be used. A convenient size is one and one-half to two feet wide by three feet long. The sawdust before using is heated five to ten minutes in boiling hot water to kill all molds or fungus growths. Also all cloths used more than once are boiled in the same manner. The most convenient receptacle in which to heat the sawdust is an ordinary wash boiler and the heating may be done on the kitchen stove. The hot water should be drained off and the sawdust allowed to cool down so that it can be easily handled with bare hands before using. The box is filled about half

Fig. 8.—Removing Kernals for the Germination Test.

Fig. 9.—Placing Kernels in Germination Box.

full with sawdust which is levelled and pressed down to a smooth surface. A piece of white muslin is marked off checker-board fashion. (See Fig. 7) the squares being about two inches square. The blocks or squares are numbered from one upwards and the cloth is placed on top of the sawdust and tacked at its corners to the box.

The ears for testing may be laid side by side on the floor and for convenience in counting every tenth or twentieth ear may be reversed end to end. Three kernels are taken from each side of the ear in different rows, one kernel from near the butt, one from near the middle and one from near the tip of the ear. The six kernels are placed at the butt end of the ear from which they were taken. (See Fig. 8). After the kernels are removed boards may be laid over the rows of corn to keep them from being disturbed until the test is completed.

Place the kernels from ear numbered one in square number one of the germination box, from ear number two into square number two, and so on until all the squares of the box are filled. (See Fig. 9 and 10). Then place over this a cloth considerably larger than the box and cover with two or three inches of moist warm sawdust and set away in a warm room where it will not freeze. The kitchen or sitting room is a very suitable place. After four to seven days when the roots of the kernels are mostly two or more inches long and the top shoots one-half inch or more long, remove the cover carefully so as not to misplace any of the kernels. (It will be found advantageous to place a cloth over the kernels before the cover is put on to prevent the kernels from sticking to the upper cover). Examine the kernels of each square and if in any square one or more kernels fail to germinate or if the kernels show weak germination the corresponding ear should be rejected.

The germination test being completed the ears before shelling should be tipped and butted. The tip kernels are too small and the butt kernels too large and irregular in shape to plant well with those from the middle portion of the ear. They make it impossible to secure a uniform drop. Furthermore the top portion of the ears are the most likely to be moldy, or otherwise injured, and poor in vitality. Where an edge drop planter is used a more uniform drop can be secured by runnng the shelled corn through a grader.

CORN BREEDING.

Every farmer with ten or more acres of land should not only choose a good variety of corn and select and test his seed but should have a seed patch or an ear to the row test plot.

The seed test is set apart from the rest of the corn land to produce seed for the next year's crop. It is planted with the very best ears obtainable. These ears are shelled together. The number of ears and size of plot depends on the amount of seed wanted. For the average farmer forty ears is all that is needed. The best location for the plot is on the south or west side of the field as the wind is usually in a southwesterly direction during the tasselling period. If, however, any other variety of corn is growing within eighty rods of the field in the direc-

tion of the prevailing wind and there is no hedge or other obstruction between, it is advisable to put the best corn in the centre of the field to prevent mixing with the other varieties. Forty ears will plant about three acres which should furnish fifteen bushels of good seed. From this fifteen bushels the best forty ears should be selected for planting the next year's seed plot.

This method can be made much more productive of good results by selecting not only the best ears but by selecting from the best stalks. By selecting from good stalks the female parent or dam of the ear is known to be good and the only uncertainty is the male or sire side. The latter is very uncertain for the ear may have been fertilized by the pollin from one or more of the many stalks within a considerable radius. The sire may have been one of the scrub plants or one of the best ones.

Fig. 10.—Showing Germination Box Filled and Ready for Top Layer of Sawdust.

To lessen the chance of polination by a scrub plant it is well to remove the tassels from the most inferior stalks. To get all of the tassels removed it will be necessary to go over the field every two or three days for about two weeks. The tassels should not be cut off but should be removed by pulling them out.

One advantage of having a certain portion of a field to select the seed from instead of selecting from the whole field or all of the fields is that the corn can be left longer before it is cut and the work of selecting is made a job of itself and is done more carefully. A farmer can soon go over an acre or two and select out the seed corn and store

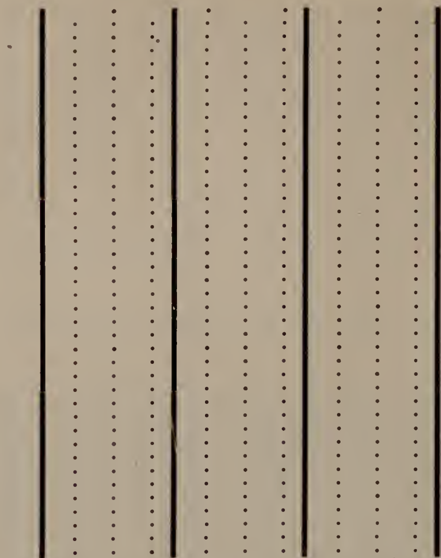
it while if his operation had to be scattered over several acres he might not attempt to save any until husking time.

The ear to the row test plot is a plot in which the choicest ears obtainable are planted in rows side by side, ear one in row one, ear two in row two, and so on twenty-five or more being used in most cases. Each of the ears tested are usually scored and described for later reference to furnish a basis for ascertaining the amount of improvement as the breeding continues and as to the relation of ear characteristics to the yield. Some of the most important things to record are length, circumference and weight of ear, number of rows, depth of kernel and degree of indentation.

The rows of the breeding plot in the fall are harvested separately and the weights of corn and stover ascertained. It is also well to ascertain the amount of unmerchantable or unmarketable corn in each, and average height of ear, strength of stalk, and number of stalks per row if there is any marked difference between the rows.

There are two methods, with some modifications, of conducting the ear-row-test plot. The one may be called the Illinois method and the other the Ohio method. The method in use by the Maryland Experiment Station is a modification of the Illinois method. Forty ears are planted in forty separate rows and alternate ends of each row detasseled. The detasseling is done to insure cross fertilization. An ear fertilized from the pollen of the stalk on which it grows is liable to produce inferior offspring. In the fall before cutting the corn some of the best plants are selected from the detasseled ends of the rows and saved separately. After harvesting, the best ten to twenty rows, as determined principally by yield and partly by quality of corn, are selected and only seed from the selected plants of these rows are used in the next year's breeding plot.

The Ohio method differs from the above method in that no detasseling is done and no seed saved from the ear-row-test plot and at the time of planting one-third or more of each of the ears are not planted but are preserved until a year later when the remnants from the four which produced the most corn of good quality, the year previous are planted in a plot by themselves and mated, one of the ears being used as male or sire and the others as dams, the dam rows being detasseled. In mating shorter and greater number of rows of each ear are used then in the ear-row-test. The plan of mating is shown in the diagram below, the heavy line representing the sire rows and the three intermediate dotted lines representing the dam rows. The three rows between any two sire rows may be planted to the same dam ear or one row to each of the three dam ears. Enough rows should be planted so that the plot is nearly square as a square plot is less likely to be poorly polinated than a long slender one.



The best ears from the mating plot together with the best ears of the same variety from the field are planted in the ear-row-test plot for the next year and selected as before.

It is probable that the following combination of the two methods will give better results than either. Have a mating plot from the remnants of the highest yielding ears of the previous year as in the Ohio method, only use eight ears instead of four. Select about eight of the ears for the next year's breeding plot from the mating plot, twenty to thirty ears from the eight or ten highest yielding rows of the ear-row-test, and others from the general field, multiplication plot or some outside source. Plant each of these ears (forty is a good number) in separate rows, leaving every second or third row for planting to a composite sample of the best ears of the mating plot after selecting out the eight ears for the row test. The forty rows are detasseled their whole length and are polinated entirely from the intermediate rows which not only serve as polinators but as checks on the uniformity of the land. The yield of the rows, should be compared with the yield of the two adjoining check rows before being compared with each other.

Not every farmer can afford to conduct an ear-row-test, but there should be a corn breeder in every locality who makes a business of supplying good seed to the farmers around him. Every farmer, however, who plants ten or more acres of corn can afford to have a seed patch.

A method by which many farmers attempt to improve their corn is by crossing it with other varieties and some keep crossing it every two or three years. The result is that the corn in most cases has little type and is inferior in many respects to the varieties used in making the crosses. As a general rule it is more profitable to select a good variety and breed it up by selection than to make crosses. The latter kind of work is better confined to station workers and other skilled corn breeders.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 142 FEBRUARY, 1910

THE CODLING MOTH.

(*Carpocapsa pomonella.*)

By T. B. Symons and L. M. Peairs.

INTRODUCTION.

In Maryland, as in many other States, the apple is considered the "king of fruits." While in some localities, it is not grown so extensively as the peach, it is more generally grown throughout the State than any other fruit. On account of the wide range in time of ripening of different varieties and good keeping qualities, it is the most highly prized of all fruits for home use, and for this reason there are very few farms in the State which have not at least a few apple trees to furnish fruit for the home. The hardiness of the tree itself and the ability of the blossoms to withstand late frosts especially recommend it for use in a locality having such variations in the climatic conditions during the spring, as has Maryland.

During the past few years, the people of the State have begun to realize the enormous possibilities for the growth in the State of apples for commercial purposes. Certainly no State has better natural conditions for the production of this fruit on a commercial scale. With a selection of soils suited to a large number of the best trading varieties, favorable climatic conditions, and proximity to large markets, the production of apples should prove to be a profitable industry, and may undoubtedly be expected to increase steadily. A conservative estimate places the increase in number of apple trees in the State, since the last census, at 20 per cent. According to the latest census (1900), Maryland had at that time, 1,824,183 apple trees which bore that season, 3,150,673 bushels, or over 1,000,000 barrels of apples.

Data collected by this department since that time indicates that from 40 to 60 per cent. of the annual yield is injured by the codling moth, which makes much of it unfit for market and some almost worthless for home use. This per cent. of loss from the number of bearing trees now growing in the State makes a quantity of such magnitude as to demand the attention and cooperation of every apple grower in the State, in an effort to reduce this loss. While a large number of up-to-date orchardists do spray annually for the pest, the vast majority of them do not as yet appreciate the extent of the injury it causes. Spraying for the San Jose scale has become the common practice in

the State for the reason that, if unsprayed, a tree will soon die, the scale affecting the health of the tree itself, while the codling moth injures the fruit only; and so does not force the owner to spray or lose his orchard.

For the purpose of demonstrating to the apple growers of the State, the value of treatment, experiments have been conducted during the past three years to show the great benefits to be derived by thorough spraying for this insect. Life history studies and comparisons of the efficiency of different arsenicals used for spraying, have been included in the experiments.

On account of lack of funds, these tests have not been made so comprehensive and thorough as was desired, but the results already obtained seem to justify the publication of this preliminary report for those desiring immediate information on the subject.

During the past year, the demonstration work has been extended to orchards on several of the county almshouse farms, and to a few orchards on private farms in different counties. Further discussion of this phase of the work will be given in succeeding pages of this bulletin.

We wish to extend our thanks and acknowledgments of many courtesies to Mr. E. W. Hungerford of Marshall Hall, Mr. W. L. Amoss of Fallston, Mr. J. W. Gray of Port Tobacco, Mr. Joseph Cowden of Perryville and the Superintendents and Boards of Control of the almshouse farms in Washington, Frederick, Kent, Wicomico, and Worcester counties. Credit is due Messrs. A. B. Gahan, George P. Weldon and E. N. Cory of this department, and Mr. W. C. Travers of Taylor's Island for efficient service in connection with the experimental and demonstration work.

DESCRIPTION AND LIFE HISTORY.

The codling moth (Fig. 1) is a small moth with a wing expanse of about ½ to ¾ of an inch. The color of the wings is dark gray and brown, arranged in alternate stripes across the wings, the stripes being variable in width in different individuals, so that in some cases the brown predominates while in others it gives places almost entirely to the gray. There is on the inner angle of the fore wing a fairly constant large golden-brown spot, while the outer margins of both wings are fringed with delicate scale-like hairs. The hind wings and body are of dark yellowish gray color, but are lighter than the fore wings. The fore wings which cover the hind wings when at rest, harmonize very well with the bark of the apple tree upon which the moth frequently rests during the daytime, and for this reason the moth is seldom seen by the casual observer. The adult moth flies at dusk or before dawn. It is rarely if ever attracted to lights. It is quite swift and erratic in its flight, and may easily be recognized by one familiar with its movements.

The codling moths pass the winter as larvae, which live in silken

Fig. 1.—Codlng moth, (Enlarged).

Fig. 3.—Eggs on leaf. (Enlarged).

Fig. 2.—Webs of hibernating larvae and pupae under scales of bark.

cocoons situated beneath loose scales of bark or in rubbish about the foot of the tree. (Fig. 2). In the early spring these larvae change to pupae within the same cocoons, and about the middle of April or the first of May emerge as moths. These moths soon begin to lay their eggs, either on the leaves of the apple tree or on the young fruit itself. Our observations show over 80 per cent. of the eggs laid on the upper surface of the leaves, and the remainder on the young fruit. One moth may lay from thirty to sixty eggs, and the egg laying period extends over several days for one moth. As the period of emergence for these moths extends over from a month to six weeks, the eggs may be found during a similar period.

The egg (Figs. 3 and 4) is a flat, circular, white, scale-like object when first laid. It is about the size of an ordinary pin-head. In from

Fig. 4.—Egg on fruit. (Second brood).

six to twelve days after being laid, the egg hatches, and the larva, then scarcely longer than the egg is wide, crawls out and begins to feed, often for a day or two feeding on the leaf (Fig. 5), then crawling to

the nearest apple and boring its way into this at the calyx, or blossom end. There the larva continues to feed and grow for from three to five weeks, eating the substance around the core of the apple, and in many cases so weakening the stem that the apple falls before reaching maturity or even before the larva makes its escape. (See Fig. 6). The mature larva (Fig. 7) is normally about five-eighths of an inch in

Fig. 5.—Leaf partially eaten by newly-hatched codling moth larvae. One larva fed upon this for over a week.

length and one eighth in diameter. It is white in color, but shows pinkish or flesh tints through the skin on the dorsal or back side. Occasionally, especially in over-wintering larvae, this pink tint is absent, and it seems to be more pronounced in larvae of the first or summer brood. The head is brown, with darker, almost black, mark-

ings, while the hardened plates occurring on the back of the first segment and at the posterior end are lighter brown in color. Scattered over the body are many circular, very slightly raised, tubercles from which fine hairs project. The larva has three pairs of true legs located on the three segments immediately behind the head, while on the abdomi-

Fig. 6.—Larva of Codling moth feeding in apple.

nal segments are five pairs of fleshy unjointed protuberances commonly called legs, but more properly termed prolegs. The true legs are armed with claws while the prolegs are furnished with stiff bristle-like hooks arranged about their tips, by means of which they are enabled to cling to the surface upon which they crawl. On each side of each segment, may be found small slit-like openings in the center of slightly raised nearly circular areas. These are the external openings of the breathing tubes of the insect. When full grown the larva bores a hole to the surface of the apple, crawls out, and either lets itself down to the ground by means of a silken thread which it spins through a spinneret beneath the mouth, from silk glands located on each side of the thorax and extending back into the abdomen; or

crawls onto a branch and finds its way down the tree, usually stopping on the main trunk and hiding under a loose scale of bark. Those larvae which drop to the ground, may pupate in trash about the foot of the tree or may crawl up the tree and pupate under the loose bark, just as those do which crawl down the trunk. We have said that these larvae pupate under the bark or in trash. About 80 to 85 per cent. as shown by observations of this department pupate within a few days. The others remain in their silken cocoons until the following spring as the over-wintering larvae previously described.

Larvae pupate not only under loose scales and in crevices in the bark, but they will take advantage of the protection offered by bands of cloth, paper, burlap or other material loosely fastened about the tree. Here a large majority of the larvae will hide and form their cocoons. Anything leaning against the tree or hanging on the main branches is also likely to attract them by furnishing a suitable protection and hiding place.

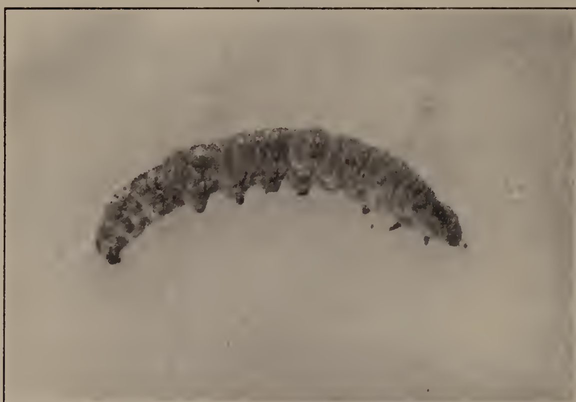


Fig. 7.—Larva of codling moth. (Enlarged four times).

The cocoon in which the larva pupates is composed of white silk very thickly woven, and if situated in a crack or hole usually fills it completely so as to keep out moisture. If on the surface of the bark, it is usually nearly circular, flattened, and almost if not quite impervious to moisture. (See Fig. 8).

The pupa (Fig. 9) is brown in color, varying in shade as it may be either very light or quite dark, about one-half inch in length. It is larger at the head end and tapers gradually toward the posterior end.

The earliest appearance of adults or moths in the records kept by this department is April 8th, 1908, and the next April 14th, 1909. Only isolated individuals are recorded on any date previous to April 24th. From this date they become more numerous but are still few in numbers until after the first of May. These figures vary from year to year, and indications are that the usual date for their appearance in numbers

Fig. 8.—Cocoon of codling moth. Also shows larva which had been removed from under it.

Fig. 9.—Pupa of codling moth. (Enlarged

is later rather than earlier than the above. Eggs are laid soon after the emergence of the first moths, probably within forty-eight hours, but the first eggs on record for the past years at College Park, are one on April 25th, 1908, one on April 28th, 1909, and two on May 3rd, 1909. A more extended search, prevented by other duties, would in all probability have revealed more eggs on and before these dates. Eggs from first brood moths were found from the dates named above up to the time when second brood moths appeared, after which time it was in most cases impossible to determine to which brood the eggs belonged. We know, however, that eggs from the first brood moths are found until nearly the first of July, and evidence seems to bear out the statement that they appear after that date.

Full grown first brood larvae were observed as early as May 26th, and the first of the second brood moths on June 14th. These are exceptional, however, as second brood moths do not come out in numbers much before the first of July.

Full grown larvae are abundant under the bands after the first week in June; only in exceptional seasons do any but isolated individuals appear before that date.

The large majority of full grown first brood larvae are found between June 18th and July 10th, and the moths from these from July 1st to August 1st. First brood larvae may be found in the month of August, but of those which emerge later than the last third of July, only a small per cent. pupate and produce a second generation; most of them go into their over-wintering cocoons and do not pupate until the following spring.

Our observations show eggs from the second brood moths as late as August 23rd, but from other data and observations from other stations, we may conclude that they continue to be laid at least until the middle of September.

We have found and recorded full grown second brood larvae in small numbers before the first of August, and others still in the fruit after the first week in October; in fact, it is a common occurrence to find larvae crawling from fruit picked after October first, and many times cocoons may be found in cracks and corners of barrels and boxes in which the apples are packed, and on the walls of packing sheds and buildings in which apples are stored. The maximum number of second brood larvae reach maturity in the month including the latter half of August and the first two weeks of September. (Maturity as used here, and in this connection heretofore, means, full growth, as the mature individual, strictly speaking, is the moth itself.)

The average time that the insect remains in the fruit varies from three to four weeks, it being usually a few days longer for the first brood than for the second.

We have no evidence which would indicate the presence of even

a partial third brood in this locality. Statements that such a brood did occur were probably based upon misconceptions of the length of time during which individuals of a single brood might be found, and of the overlapping of the first and second broods.

As stated before, the larvae of the first brood in most cases hatch from eggs laid on the upper side of the leaves and enter the fruit at the calyx end, either forcing their way through the natural opening between the calyx lobes, or boring their way through the flesh of the fruit itself. The eggs of the second brood, on the contrary, are more frequently laid on the fruit and over 75 per cent. of these second brood larvae enter the apples at the side, some of the remaining 25 per cent. at the stem end, and what few remain, at the calyx end. The eggs which are not laid on the apples are found on the upper side of the leaves, as is the case with the first brood. Instances are on record of eggs being found on the stems of apples or on small twigs, but these are so rare that they need not be considered in the discussion of the normal habits of the insect.

Further observations, designed to secure more complete and definite records of the habits of this insect in all parts of the State of Maryland, are in progress, and it is planned to continue them during the coming season.

SUMMARY OF LIFE HISTORY.

Over-wintering larvae pupate in early spring and emerge as moths about the time when the apples are in bloom. These moths lay their eggs on the upper side of the leaves; the eggs hatch in from six to twelve days and the larvae enter the young apples at the calyx. The second brood larvae appear about six weeks later than the first brood, are hatched from eggs laid, as a rule, on the apples themselves, and enter the fruit at the side. Full grown larvae leave the fruit and pupate under loose scales of bark, in crevices and holes in the bark, and among trash at the foot of the trees.

NATURE OF THE INJURY.

The description of the life history and habits of the codling moth has shown that it can render a crop of apples practically worthless. Infested fruit usually drops from the tree before the normal ripening time and rots on the ground, as the opening through which the larva escapes permits the entrance of bacteria and molds, which cause the fruit to decompose much sooner than it would otherwise have done. (Fig. 10). Of the infested fruit that does hang on the trees until picking time, a great per cent. is undersized, some of the apples are one-sided or otherwise misshapen, many more are disfigured by the presence of the borings clinging to the skin, and of the holes them-

selves, and all have poor keeping qualities, so are unfit for storage.

Large apple markets today will not pay as good a price for fruit from unsprayed and neglected orchards as they will for that from sprayed and properly tended ones, as the trade demands a good clean and sound quality of fruit.

The injury from the moth is easily recognized in the orchard. Fig. 11, shows a typical case where the borings have been pushed out through an opening made just where two apples hang together, as is often the case; such apples are more frequently attacked than those which hang alone.

Fig. 10.—Apple injured by larva of codling moth.

NATURAL ENEMIES.

Natural enemies of the codling moth are more or less efficient aids to man in the suppression of the pest. They may be placed in three general groups. Birds and other vertebrates, insect enemies, and fungus diseases. Of these, the birds are the most valuable. Many species of birds feed upon the larva of the moth and possibly occasionally on the moth itself. Of the birds, the common woodpeckers and sapsuckers are probably the most extensive feeders on the larvae, as their habit of digging out insects hidden under the bark or trees gives them access to the worms where other insectivorous birds could

not reach them. As some of these stay with us throughout the winter they have a much longer season in which to feed upon the worms than the summer residents. We have known of no instance in which the egg has been eaten by birds, and on account of its small size and inconspicuous appearance it is probably rarely, if ever, molested. The large majority of the birds commonly found in an orchard, robins,

Fig. 11.—Work of larva of codling moth, showing borings. (Photo by Gahan).

bluebirds, thrushes, woodpeckers, and many other species, feed to a greater or less extent on codling moth larvae, and those which do not feed on this pest do attack others. This forms one of the most powerful of all arguments in favor of the protection and encouragement of birds by farmers and fruit growers. They may easily be forgiven for what little damage they occasionally do the fruit, for which the owner has been repaid many times by their services.

Other vertebrates which have been said to attack codling moths or their larvae are bats, mice, and shrews, but they are of relatively small importance compared with birds.

Insect enemies include two general groups, viz.: predaceous insects, which capture and devour either the larvae or the adults; and parasitic insects, which may infest either the eggs or the larvae.

On account of the sheltered situations in which the larval stage of the codling moth is passed it is much less subject to the attacks of either of these groups than are the majority of the larvae of insects of this order. The predaceous insects which feed upon the larvae include a large number of species. One of the most important of these in this locality is a small red ant (Solenopsis sp.), which attacks the larvae as they are spinning their cocoons. Our observations on the larvae pupating under bands on trees have shown at times as high as 50 per cent. of them killed, and partially devoured, by these ants. We have found others which had hidden among rubbish on the ground and been killed by different species of ground beetles, and several other species of beetles have been reported as preying upon them. The parasitic insects attacking this pest belong to the order Hymenoptera, with the exception of one two-winged fly which has been reported as a parasite. These parasites lay their eggs upon the larvae after they have left the apple; the eggs of the parasites hatch and their larvae live within the bodies of the codling moth larvae, ultimately killing them. Other parasites have been described which are so small that they are able to, and do, develop within the eggs of the codling moth.

Insect enemies of the codling moth, while of great value in keeping down its numbers, cannot be depended upon to be of material assistance to the fruit grower in this respect. The sheltered life of the larvae makes it impossible for their enemies to reach any but a small proportion of them.

Fungus diseases, according to observations at this and other stations, play a not unimportant part in the suppression of the pest. An average of over 15 per cent. of all the larvae found under the bands on experimental trees during the season of 1908 were found to be infected with a fungus disease, as yet undetermined, which seemingly killed all it attacked. The observations during other seasons do not indicate that this was an unusually large percentage of infected worms. However, since there seems to be no means by which we may cause a more rapid spread of the disease, we cannot look for it to affect a much greater percentage of the larvae in the future than it has in the past.

We may conclude then, that while natural enemies do undoubtedly diminish, to a large extent, the numbers of these insects, none of them need be considered in up-to-date orchard management, except the birds, which should be fostered and encouraged as much as may lie in our power.

MEANS OF CONTROL.

As previously stated, natural enemies of the codling moth cannot be counted upon to hold it in check enough to keep it from injuring almost the entire crop of apples in orchards where some artificial means of control is not used.

The artificial means employed to control this insect may be grouped under two different heads; cultural methods, and spraying, both of which are practiced in up-to-date orchards. Under cultural methods we include not only cultivation, but also keeping the dead scales of bark scraped off the trees, pruning, and burning the rubbish which naturally accumulates in the orchard, keeping fallen apples picked up and either used or destroyed, and in some cases thinning the fruit. Entire control of the pest, however, is secured only by spraying; thorough, repeated and persistent spraying; spraying at the right time, with the right materials and with the right kind of apparatus.

In spraying for the codling moth, it is necessary to consider several facts. First, the insect causes injury by eating into the fruit, and rarely does the spray come into actual contact with the insect, therefore the so-called contact sprays, such as are used for scale insects or plant lice should not be employed, but stomach poisons such as Paris green, arsenate of lead, or other arsenicals, must be used. Second, the insect enters the fruit usually within forty-eight hours after hatching, and is thereafter beyond our reach, so the spray must be applied in time. Third, the fact, to which attention has already been called, that the hatching period for the eggs of one brood extends over a considerable space of time; therefore to get the best results two or more sprayings must be given. Fourth, in Maryland there are two broods of the codling moth, and to prevent injury by the second brood larvae one or more midsummer sprayings may be applied. In spraying for first brood larvae, it must be borne in mind that they enter the fruit at the calyx, therefore the spray must be applied before the lobes of the calyx close enough to exclude the spray. Fifth, sprays followed immediately by heavy rains should be repeated. Sixth, spray only with a pump which will give good pressure, not less than 80 pounds, and over 100 pounds is much better, so as to force the spray into the calyx. Do not spray until nearly all the petals have fallen from the blossoms on account of danger of injury to the blossoms and risk of killing bees which are important agents of pollination.

Failure to observe these points often cause poor results from the spraying, while proper attention given them should insure an apple crop free from worm injury.

MATERIALS AND APPARATUS USED FOR SPRAYING.

As previously stated, spray for the codling moth must consist of some material which is poisonous to the insect when taken internally, that is to say, one of the so-called stomach poisons. Among these

Fig. 12.—Spraying in orchard at Boonsboro.

we find Paris green, London purple, arsenate of lead, arsenate of soda, arsenate of lime and others. The most widely used of these are Paris green, and arsenate of lead, and it seems that arsenate of lead is destined to replace the Paris green to a greater extent in the near future.

Arsenate of lead may be purchased ready for use, or prepared at home by mixing together arsenate of soda and acetate of lead. Many brands of the commercial product are on the markets, among the standard brands being the following:

"Disparene," manufactured by the Bowker Insecticide Company, Boston, Mass.

"Eagle Brand Arsenate of Lead," Adler Color and Chemical Works, New York.

"Grasselli's," Grasselli Chemical Company, Cleveland, Ohio.

"Orchard Brand," Thomsen Chemical Company, Baltimore, Md.

"Swifts," The Merrimac Chemical Company, Boston, Mass.

"Vreelands," The Vreeland Chemical Company, Little Falls, N. J.

"Rex," The Rex Company, Omaha, Nebraska.

"Hemingway's," The Hemingway London Purple Company, New York, N. Y.

"Star," Fred D. Lavenburg, New York and Chicago.

"Sherwin & Williams," The Sherwin & Williams Company, Newark, New Jersey.

The arsenate furnished by these firms usually comes in paste form, and is sold by weight. It may be secured in form of powder. Some companies manufacture spray compounds said to be composed of arsenate of lead mixed with the constituents of Bordeaux mixture; all that remains for the orchardist is to add water and spray. These compounds should be bought under guarantee and fully tested before being used extensively. They are probably more expensive than the home-made Bordeaux, but may afford some saving of time and apparatus.

Arsenate of lead when purchased in form of paste, should be accompanied by a guarantee stating that it has not been weakened by the addition of water, and whether dry or in paste, it should be guaranteed to be of standard strength, as its composition is known to vary. To be of standard strength, lead arsenate must contain, not more than 50 per cent. water, not less than 12½ per cent. arsenic oxide, and not more than 75 per cent. of water soluble arsenic oxide, no foreign substances which may affect the strength of the arsenate or injure the foliage of plants.

Paris green may be purchased from any firm dealing in insecticides or chemicals. Home-made arsenate of lead may be prepared by mixing acetate of lead with arsenate of soda in solution. The convenient form in which the commercial arsenate is put on the market, together with its reasonable price, tends to discourage its preparation by the fruit grower himself. There is practically no difference so far as results are concerned, between the home-made and the commercial brands.

A widespread misunderstanding concerning the use of Bordeaux

mixture is prevalent among a great many of our farmers. It should be understood that while Bordeaux is almost universally applied along with the spray used for codling moth, it is in no sense of the word an insecticide, but is used solely as a preventive of plant diseases, and has no effect whatever on the codling moth, nor on any other insect, except perhaps unprotected larvae with which it may come in actual contact.

For codling moth spraying, arsenate of lead of any good brand at a strength of one and a half to two pounds of the arsenate to fifty gallons of water is preferable. The arsenate should be placed first in a bucket with a small amount of water, and mixed thoroughly until a very thin paste is formed, then more water should be added, and the mixture poured into the spray barrel or tank with the requisite amount of water. Paris green may be used at the rate of one-third of a pound to fifty gallons of water or Bordeaux mixture. In preparing the spray the Paris green should also be mixed with a small quantity of water before being put into the barrel.

Some of the advantages claimed for arsenate of lead rather than Paris green are as follows:

First: It remains suspended in the water much better than does the Paris green, which, even where a good agitator is used, is less likely to settle so that the material in the bottom of the tank is much stronger than that first used.

Second: The arsenate of lead sticks on the foliage and fruit much better than the Paris green, and will be more efficient under rainy weather conditions.

Third: As shown later in reports of experiments, the arsenate of lead is more efficient, Paris green tests showing on an average two to four per cent. greater infestation than the arsenate tests.

Arguments in favor of Paris green are its cheapness, its ease of preparation, and the fact that it is more often accessible and better known to the general public.

Since the main thing to be desired in spraying is effectiveness, apparatus and methods most likely to produce this result are ones to employ. One of the most important points to consider in this connection is the type of nozzle to use. Some growers and station workers recommend a nozzle that throws a very fine misty spray. Others prefer one which deliver a greater volume of spray. A nozzle which will throw with proper pressure a fairly large amount of spray, one free from mechanical defects and with good carrying power, will, according to our observations, do the best work. Good nozzles for this purpose are those of the "Friend" and "Mistry Junior" type, preferably those set at an agle on the spray rod, and having various discs with different sized apertures. These nozzles have largely superseded the older "Vermorel" type in Maryland, and are preferable because they do not clog readily, and are much easier to manipulate among the branches of a tree, their construction making them less liable to catch on twigs and small limbs.

The spray rods used should be, for large trees, as long as is consistent with their proper handling. The usual length is eight feet, but ten and even twelve foot rods are in use for some purposes. The hose should be of good quality and of sufficient length, at least twenty-five feet for each lead. There are some firms now manufacturing metal bound hose which gives very good satisfaction and has excellent wearing qualities, the metal keeping the rubber from expanding and so preventing leaks. The metal also protects the hose from external wear.

An essential point, and one much neglected, is to have all connections absolutely tight, and to have all "cut off" valves with which each rod should be supplied, properly adjusted so there shall be no leaking. There should also be a cut off at the pump or tank so that the pressure may be cut off from the hose leads by the operator. For an outfit using two leads of hose, what is known as a "three-way valve" is preferable, as its use enables the operator to shut off the pressure from either or both leads of hose at will. Nothing so quickly brings spraying into disrepute among the laborers as leaky apparatus, therefore, it is for the owner's best interest to see that the apparatus is kept in good repair for this reason, as well as to prevent waste of materials.

The size and the character of the spray outfit will necessarily depend to some extent upon the size of the orchard to be treated. For small family orchards, a barrel pump may be made to do very good work, but for commercial orchards, a power sprayer of some sort is almost a necessity unless unusually rough ground or very cheap labor makes it more profitable to use the barrel type. There are three kinds of power sprayers in general use: Those using gasoline engines to run the pump; traction or "geared" machines, where the horses pulling the outfit also furnish the power by means of a pump geared to the truck, which pumps the liquid into a compression tank or air reservoir when the outfit is moving from tree to tree; and third, the gas sprayers, which do not have pumps, but are operated by means of compressed carbonic acid gas in iron cylinders. Here the liquid to be used is placed in an air-tight tank and the gas under pressure is liberated into the tank just so fast as is necessary to keep up pressure sufficient to spray properly. This last type of outfit seems to furnish in theory at least the ideal way to spray, on account of the minimum of labor involved and the possibility of keeping the pressure constant at any point. It is subject to many objections. Chief among these is the expense. Aside from the first cost, there is considerable expense involved in having the gas cylinders recharged, and often aggravating delays are caused from the fact that they can only be charged by means of special apparatus located usually in large cities. Mechanical defects in the working are often found. The pressure in the gas cylinders is so great that it is difficult to keep all connections tight, and a leak once started is very hard to repair. However, when in good condition they are convenient to operate. Special apparatus by means of which air is

compressed in separate tanks at a central point may be installed, but such an outfit is quite expensive.

Gasoline engines are frequently used for power, and will supply a very good pressure at a reasonable cost. A person more or less familiar with a gasoline engine should be employed to run such an outfit, as otherwise there is apt to be loss of time due to the irregularity of the engine. More especially is this true in very cold weather. It is necessary to have the engine covered over to protect it from the spray if the best of service is desired.

A rather new type of outfit is the traction or geared sprayer. It is fully as cheap at first cost as the gasoline and gas outfits and requires no outlay for fuel or recharging of gas cylinders. The mechanism is fairly simple, and it may be operated by any intelligent farm laborer. Most makes will produce ample pressure and give very satisfactory results generally. The character of the power sprayers depends upon conditions and the selection of the type must be left to the individual.

Orchards up to ten or twelve years of age may be sprayed from the ground by the use of ordinary rods, but large trees to be treated thoroughly should be sprayed from some sort of a tower, usually constructed on the trucks upon which the spray outfit is mounted. One man should be stationed in the tower and another on the ground to spray the lower limbs. It is often desirable for the man on the tower to have an extra long spray rod for very large trees, as otherwise he might not reach the central portion of the top. Here again the advantage of the "angle" typé nozzle is shown, as with it the rodman can spray different sides of the limbs from one position and is enabled to do a much more thorough work than would otherwise be possible.

Large trees are ordinarily sprayed from at least two sides, and here the direction of the wind must be taken into consideration, advantage being taken of it to help the carrying of the spray. It is bad policy to spray on a violently windy day, as the job will not be thorough, but a moderate wind is rather an advantage than a disadvantage to a skilled operator.

GENERAL SUGGESTIONS.

Properly pruned trees are very much easier to spray well than others, and attention should be given this fact when the pruning is being done. Points most to be desired from a sprayer's standpoint are, a low spreading head, no interlacing branches, and absence of branches close to the ground. Since none of these points is at variance with the best pruning methods, a little foresight will simplify the spraying problem greatly from this aspect.

Planting has also to do with best results in spraying. Many times trees are planted so close together that when they reach maturity the branches more than fill the space between the rows and tend to impede the progress of the sprayer. Close planting is undesirable for other reasons, so plenty of room should be provided for the spray outfit when the orchard is being planted.

In orchards where many varieties are to be planted it is well to consider the dates of blooming of the different varieties, so that those which bloom at approximately the same time may be planted together. This will facilitate spraying greatly, or will at least tend to make it more effective by having varieties sprayed at the proper time. It will tend also to prolong the available, if not the actual spraying season. Blossoming dates for the different varieties may be secured as a rule from the nurserymen from whom the trees were purchased. The Horticultural Department can also furnish these dates for the more common varieties.

Another consideration is water supply. It is very desirable to have this near by, or in, the orchard, so that little time shall be lost in replenishing the supply in the spray tank. An elevated reservoir or water under pressure is a very great help in this connection. Many other points, will from time to time suggest themselves to the practical orchardist.

THE COST OF SPRAYING.

Considering the profits to be derived from the operation, the cost of spraying is relatively low. In fact, it is, strictly speaking, much more expensive not to spray than it is to spray, the unsprayed orchard being often merely an incumbrance to the land, rather than a source of profit, as is the sprayed orchard.

The materials used in spraying are relatively cheap. Paris green costs from thirty to thirty-five cents per pound. Lead arsenate from nine to sixteen, or when purchased in one pound lots only, may cost as much as twenty-five cents. The materials required for the Bordeaux mixture, are copper sulphate or blue stone at from five to eight cents per pound, and lime at one-half cent or less per pound. A barrel of spray when combining treatment for codling moth and fungus diseases requires; two pounds arsenate of lead at twelve and one-half cents, five pounds of copper sulphate at six cents and five pounds of lime at one-half cent; the whole amounting to fifty-seven and one-half cents. This amount of spray applied under average conditions, will spray twenty apple trees of the size usually reached by a good healthy fifteen-year-old tree, making the cost of material per tree less than three cents. The cost of labor varies so that is is difficult to make an accurate estimate. Three men with a good barrel outfit can spray at least 150 trees in a day. With a supply tank holding more liquid than the barrel, they will be able to spray more, as less time will be consumed in replenishing the supply.

A conservative estimate of the value of the labor of three men and a team on a Maryland farm would be five dollars. Say the outfit sprays 160 trees, using eight barrels of spray, worth $4.60, the average cost per tree of this spraying would be six cents, which seems to be a sufficiently liberal estimate. This is for the first spraying in which an extra large quantity of material is used. For subsequent treatments the cost per tree would probably be less than five cents.

The spraying of an orchard for the season should not cost, at the very outside, more than twenty cents per tree, when three or four treatments are applied, and fifteen cents would probably cover the cost.

Where gasoline outfits are employed, the cost of fuel is compensated for by increased efficiency and saving of labor. Traction or "geared" sprayers are even less expensive to operate, as in many instances one of the rodmen acts as teamster as well, thus necessitating only two men instead of the three required for the hand pump.

PROFITS FROM SPRAYING.

The profits from spraying are even harder to estimate than the cost of the operation. In the experimental orchard at Marshall Hall in 1908, the crop of apples from the unsprayed trees was negligible, scarcely worth the picking, while on the trees sprayed, even those which received but a single treatment, the crop was, in spite of the fact that the trees were small and the blossoms very light, worth two and a half dollars per tree. Previous to this time, the owner had not realized anything from the orchard.

The yield of saleable apples secured from the sprayed trees in the station orchard, is at least double that from the unsprayed trees, and when, as is the case here, the yield per sprayed tree is in the neighborhood of ten bushels per tree, the profit from spraying is easily above two dollars per tree. In several of the demonstration orchards, the profits were even more marked than those given above.

In an orchard where there are forty trees per acre, with an outlay of less than twenty cents per tree or eight dollars per acre, the orchard can be made to pay from eighty to one hundred dollars per acre more than it would otherwise have paid. No one can doubt the wisdom of the investment. The average farmer would not hesitate to invest a like amount in fertilizers for his crops if he were sure of a proportionate increase in yield. The orchardist cannot afford to neglect spraying any more than he can afford to allow his fields to go unfertilized.

THE FIRST SPRAYING.

The first spraying for the codling moth should be done just as soon after the petals begin to fall as possible. Spraying before this time, that is while the trees are still in full bloom, is likely to be attended with bad results, since spray may prevent proper fertilization of the blossoms if it does not actually kill the organs of reproduction.

The application of the spray must not be unduly delayed either, on account of the fact that soon after the petals fall the lobes of the calyx draw together, making it impossible to force the spray into the calyx cavity, through which a large majority of the larvae attempt to enter the apples. Soon after the calyx lobes close, or indeed even while they are closing, the fruits lose their upright position and begin to

Fig. 13.—On the left, apples in proper condition for first spray. On the right, calyx lobes closed, almost too late for first spraying.

droop, thus making it much more difficult to get the spray on the blossom end of the apple. Fig. 13 shows on the left apples with calyx lobes still open, and in proper condition to spray, and on the right the calyx lobes drawn together, and too late for the first spraying.

The date for the first spraying in Maryland varies according to locality and season, from the last week in April to about the 10th of May, but it embraces a comparatively short space of time each year for reasons given above.

THE SECOND SPRAYING.

The first spraying should be followed by a second in from one to two weeks, depending upon weather conditions, on account of irregularity of appearance of the moths and the consequent late hatching eggs. If the weather remains dry after the first spraying, it is safe to postpone the second for ten days or two weeks, but if the first spraying is followed within a few days by heavy rains and damp weather, it is best to apply the second at a date not later than one week after the first. It should be understood, of course, that any spray followed by heavy rains before it has a chance to dry thoroughly must be repeated, and such repetition is in no sense the second spraying referred to here.

ADDITIONAL SPRAYING.

In some cases, it may be desirable to apply a third spraying. This should be put on in from ten days to two weeks after the second regular spray, and may or may not include Bordeaux.

In cases where the second brood or summer generation is abundant, it is necessary, in order to get the best results, to spray again from three to five weeks after the third spraying, or from four to seven weeks after the second. This date is usually about the first week in July. The material used at this time is arsenate of lead or Paris green, at the usual strength, with or without Bordeaux.

SUMMARY OF SPRAYINGS.

First spraying: Applied when the petals have nearly all fallen, but before the calyx closes or the fruit droops.

Arsenate of lead at 1½ to 2 pounds or Paris green at 5 to 10 ounces, with or without Bordeaux (when Paris green is used without Bordeaux, some lime should be added to the spray). This spraying is the most important and should be very thorough.

Second spraying: Follows the first after an interval of from a week to ten days. The same insecticide is used here as for the first spray, and Bordeaux is usually included.

Other sprays sometimes applied, are the third spring spraying, following the second after ten days, and the summer spraying after the second brood moths have begun to emerge.

Ordinarily these later treatments will not be necessary, but to get the very best results they are often advisable.

EXPERIMENTS.

The experiments upon which the facts stated in this bulletin are based to a large extent, extended over a period of three years. During the season of 1907 the experiments were nearly all located at College Park. Tests that year were applied to trees in theExperiment Station orchard. The following season (1908), the department conducted experiments in Charles county, on the farm of Mr. E. W. Hungerford, at Marshall Hall, and at Boonsboro, in Washington county, on a place owned by Mr. Joseph Blecker, as well as at College Park, where the experiments of the previous year were continued.

In 1909 further experiments were applied in the Hungerford orchard at Marshall Hall, the College Park tests were continued and tests were applied at several of the county almshouse farms, and on other orchards in different counties. These, as stated elsewhere, were secured primarily for purposes of demonstration, but some data was secured from them. These tests were supplemented in many cases by observations of sprayed and unsprayed orchards belonging to private parties in different sections of Maryland.

The Experiment Station orchard at College Park, where the most extensive tests were applied, is a type of a well-cared-for orchard, and spraying had been the rule in it for several years.

Mr. Blecker's orchard at Boonsboro contained both old and young trees which had received the best of care otherwise, but had never been sprayed.

Mr. Hungerford's orchard, at Marshall Hall, the most important of all the tests in some ways, was composed of trees about twelve years old which had been allowed to go without either spraying or cultivation, and consequently was a good place to find pests of various kinds. The demonstration orchards were usually old orchards which had never been sprayed, nor had they as a rule received proper pruning and cultivation.

Life history records were obtained in various ways: By observations of the moths in the orchard and in breeding cages in the insectary, collections of eggs from leaves and fruit and observations of same in the insectary; collections of fallen fruit from sprayed and unsprayed trees; and collections of larvae and pupae in their hiding places. To facilitate the collection of larvae and pupae, bands were placed on a number of trees at College Park and on others at Marshall Hall. These bands furnished good hiding places for the full-grown larvae when they came out of the fruit, so they were easily captured by removing the bands at intervals of from five to seven days. In this way many facts were determined in the life history of the moth. Among these were the date of the emergence of the maximum number of the larvae from the apples, the percentage of first brood larvae which

Fig. 14.—View in Station orchard at picking time.

pupated at once and formed a second generation, and many other points of interest. From larvae and pupae of both first and second broods collected from under the bands and kept in the insectary, many facts relating to the lengths of different stages and relations of the two broods with each other were discovered or confirmed.

The experiments proper, consisted of tests of the relative value of arsenate of lead and Paris green, various strengths of each material being employed, and of the results to be obtained from different numbers of applications of several materials. These tests were applied at College Park, 1907, 1908 and 1909; at Boonsboro in 1908, and at Marshall Hall 1908 and 1909. They include arsenate of lead at one, one and a half, two, two and a half, and three pounds to fifty gallons of water and Paris green at five and ten ounces to fifty gallons of water.

TESTS AT BOONSBORO.

The tests at Boonsboro consisted of applications of arsenate of lead at various strengths and Paris green at five and ten ounces per barrel on Ben Davis apple trees six years old, and Paris green sprayed on a few old trees of mixed varieties.

The main point demonstrated here was the superiority in quality and appearance of the fruit sprayed with arsenate of lead over that sprayed with Paris green.

Apples from trees sprayed with Paris green at ten ounces per barrel showed over 40 per cent. of the fruit slightly russeted from effects of the spray, and while it was not seriously damaged, it was not of the first quality on this account. From trees sprayed with Paris green at five ounces apples were much more free from russeting, only eleven per cent. being affected.

On the other hand, of all the fruit from the trees sprayed with arsenate of lead, less than one per cent. showed signs of russeting, and in no case was this severe.

On account of the fact that the season of 1908 was the first in which this orchard had produced a crop of apples, the codling moth infestation was slight, even on the unsprayed trees, but here the sprayed apples show clearly the value of such treatment even in slightly infested orchards. The unsprayed trees showed an average of 88.5 per cent. free from injury by codling moth. Those sprayed with Paris green at 5 and 10 ounces, and with arsenate of lead at one pound per barrel, from 96 to 97.4 per cent. free, and those with arsenate of lead at one and a half pounds and above 98.5 per cent. free from injury from the tree that averaged worst, while some of the best trees showed more than 99 per cent. perfect. The yield was perceptibly better, as much as 15 per cent., on the sprayed rows than on the unsprayed, but no difference could be detected in yield among the sprayed trees with either solution.

The older trees included in the tests here did not furnish as good comparisons, because it was impossible to have checks of the same variety as the sprayed trees.

Fig. 15.—General view in the Blecker orchard at Boonsboro.

The average of perfect fruit from large unsprayed trees was 69 per cent.; from sprayed trees, (one spraying only) was 91 per cent.; a difference of 27 per cent. of perfect apples on sprayed and unsprayed trees. This spraying was not as thorough as was desirable on account of the lack of a tower, and the inaccessibility of the trees.

TESTS AT MARSHALL HALL.

These consisted of comparative tests of arsenate of lead and Paris green, various strengths of each being used here as well as in the Boonsboro orchard. There were also comparisons of trees sprayed only once, with those sprayed twice, and others sprayed twice in the spring, and once in midsummer, also some few not sprayed in the spring and sprayed in the summer for the second generation.

Tests applied included Paris green at five and ten ounces per barrel, and arsenate of lead at one pound and one and one-half, two pounds, and three pounds, but it was possible at picking time to get data on only the trees sprayed with the two strengths of Paris green and the arsenate at one and one-half and three pounds, and a few trees sprayed with arsenate at two pounds.

Comparisons of the different strengths of arsenate of lead seemed to prove that any amount over two pounds per barrel of fifty gallons was superfluous as there was no appreciable difference in the percentage of perfect fruit from different trees in any of the arsenate of lead tests.

The following table will give an idea of the results from different tests at this place:

Times Sprayed.	Date.	Date.	Date.	Mixture.	Strength.	Percent Infested.	Percent Free.	Average Yield.
1908								
3	May 1	May 10	July. 7	Ars. lead..	1½	1.4%	98.6%	648
2	May 1	May 11	....	Ars. lead..	1½	4.7%	95.3%	635
1	May 1	....	....	Ars. lead..	1½	8.8%	91.2%	492
2	May 1	May 11	....	Paris G....	5 oz.	7. %	93. %	598
2	May 1	May 11	....	Paris G....	10 oz.	6.7%	93.3%	660
1	May 1	....	....	Paris G....	5 oz.	11.8%	88.2%	510
1	May 1	....	July. 7	Ars. lead..	1½	32. %	68. %	297
Checks	....	....	....	....	....	43. %	57. %	65
1909								
2	May 8	May 15	....	Ars. lead..	1½	3.9%	96.1%	280
2	May 8	May 17	....	Paris G....	5 oz.	8. %	92. %	382
1	May 8	....	....	Ars. lead..	2½	8.5%	91.5%	195
Checks	....	....	....	....	....	38. %	62. %	140
1908								
1	....	....	July.	Ars. lead..	1½	32. %	68. %	297

The yield does not show definite results here, on account of unavoidable variations in amount of bloom and size of trees. In 1909 the yield was light on account of late frosts.

Fungus diseases nearly defoliated the unsprayed trees, and caused many apples to drop before picking time which would otherwise have held on. Figs. 16 and 17 show condition of sprayed and unsprayed trees at picking time.

The varieties involved in these results are Ben Davis, York Imperial and Winesap. On most of the unsprayed trees the crop was even less than is indicated in the table, many of them having not a half dozen apples at picking time, while adjacent trees sprayed, but otherwise under identical conditions, yielded two or three bushels of fruit.

TESTS AT COLLEGE PARK.

The experiments at College Park consist of tests of arsenate of lead at different strengths, with Bordeaux mixture made up according to

Fig. 16.—Sprayed tree in Marshall Hall orchard.

Fig. 17.—Unsprayed tree in Marshall Hall orchard, under same conditions as Fig. 16.

Fig. 18.—Apples from sprayed tree at Marshall Hall. On right free from codling moth injury 98 per cent.; on left, wormy 2 per cent.

Fig. 19.—Unsprayed fruit at Marshall Hall. Wormy apples in large pile; only perfect apples in small pile to the right.

different formulae, and of Paris green at two different strengths, also used in connection with the different Bordeaux mixtures. Arsenate was used at one and two pounds per barrel, and Paris green at five and ten ounces.

Throughout the experiment, there could be observed only slight differences in results from the different tests, but the composite records for three seasons for all varieties show about two per cent. better results from lead arsenate at two pounds per barrel than from any other test.

These tests included both summer and fall varieties, the following table gives in condensed form the average results from all tests on this orchard.

Spray Material Used.	Strength.	Average No. Fallen Apples.	Percent of Fruit Infested.	Percent Free From Moth.	Average No. Bushels of Picked Fruit.	No. of Picked Apples.	Percent of Picked Fruit Infested.	Percent Picked Fruit Not Infested.	Total Average Apples, Fallen and Picked.	Average Percent, Free From Infestation.	Total Average Percent Infested (Fallen and Picked.)
Ars. lead..............	2	499	2. %	98. %	13.5	2,404	.057%	99.43%	2,903	99.2 %	.08%
Ars. lead..............	1	1,054	2.3%	97.7%	14.	2,512	.078%	99.22%	3,466	98.83%	1.17%
Paris G................	10 oz.	2,673	2.9%	97.1%	8.5	1,480	1.5 %	98.5 %	4,153	97.9 %	2.1 %
Paris G................	5 oz.	1,694	4. %	96. %	5.	1,100	2.1 %	97.9 %	2,794	97.1 %	2.9 %
Grand Total for all Sprayed Trees...........	......	5,920	2.2%	97.8%	10¼	7,496	.098%	99.02%	13,416	98.3 %	1.7 %
Checks Unsprayed....	......	2,488	24.2%	75.8%	2.5	530	20.2 %	79.8 %	3,018	77. %	23. %

Average increase of marketable fruit due to spraying 7¾ bu.

Increased revenue per tree, \$3.85.

Average cost of spraying, per tree, 16 cents.

Average profit per tree from spraying, \$3.69.

This statement is based on a price of fifty cents per bushel for the apples. At no time during these experiments has fruit from this orchard sold at a lower price, and much of the fruit has sold for from eighty cents to a dollar per bushel.

Trees in this experiment were all sprayed three times in the spring and had no summer treatment.

TESTS AT CHESTERTOWN.

Experiments here were in connection with the demonstration work, and consisted of spraying a large part of the orchard with Paris green, at 5 ounces per fifty gallons. Only one application was given and that rather late in the season, but at that results show most plainly the possibilities. Fig. 22 and Fig. 23 shows picking time in this orchard.

A SUMMARY OF RESULTS FOLLOWS:

Sprayed trees:	Average yield, 14 bushels,	
	Per cent. free from codling moth	85 5-7
	Per cent. infested	14 2-7
Unsprayed trees:	Average yield, 9 bushels,	
	Per cent. free from codling moth	61 7-13
	Per cent. infested with codling moth	38 6-13

This gives for the sprayed trees twice as much perfect fruit as for the unsprayed; 5.4 bushels for the unsprayed and 11.9 for the sprayed.

The principal variety in this test was the Ben Davis.

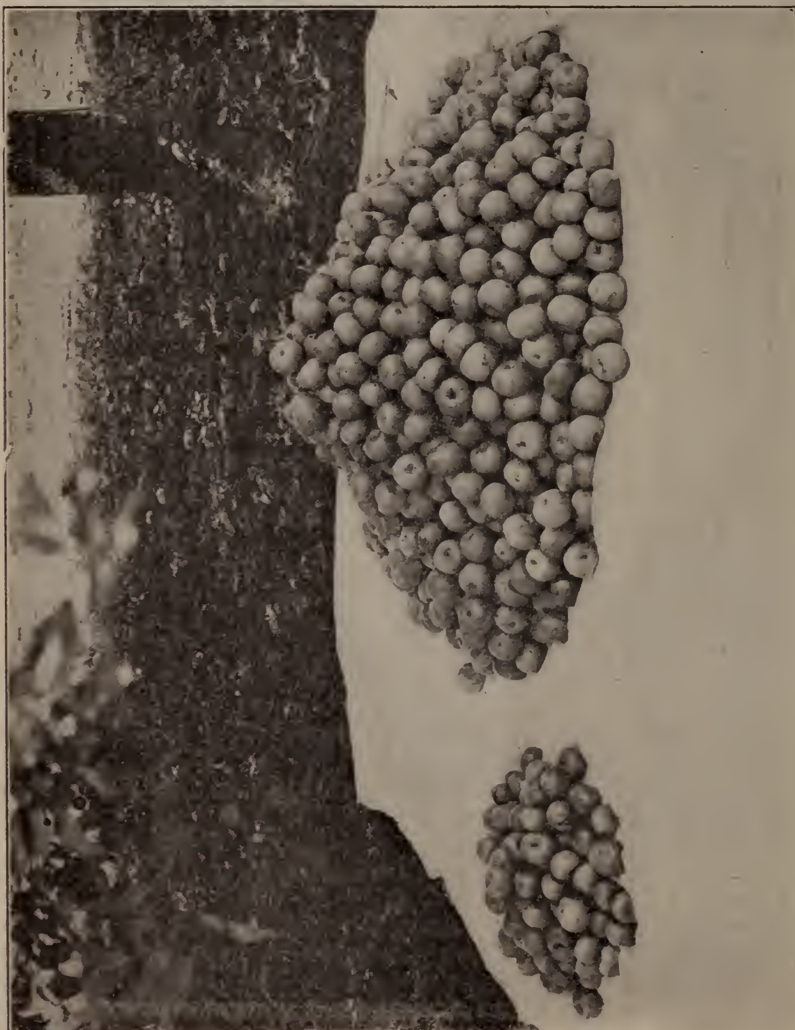


Fig 20.—Sprayed apples from Station orchard. On left codling moth, curculio and fungus injuries, on right, perfect fruit 96.5 per cent.

TESTS AT LA PLATA.

These were located in an orchard sprayed primarily for demonstration.

The trees in this orchard were sprayed three times with Paris green and Bordeaux, all conditions being fairly good except for the first spraying, which was delayed until nearly too late. Results here showed for the sprayed trees 95½ per cent. of the apples free from worms and for the unsprayed 58 per cent. perfect. Here again the yield of sound

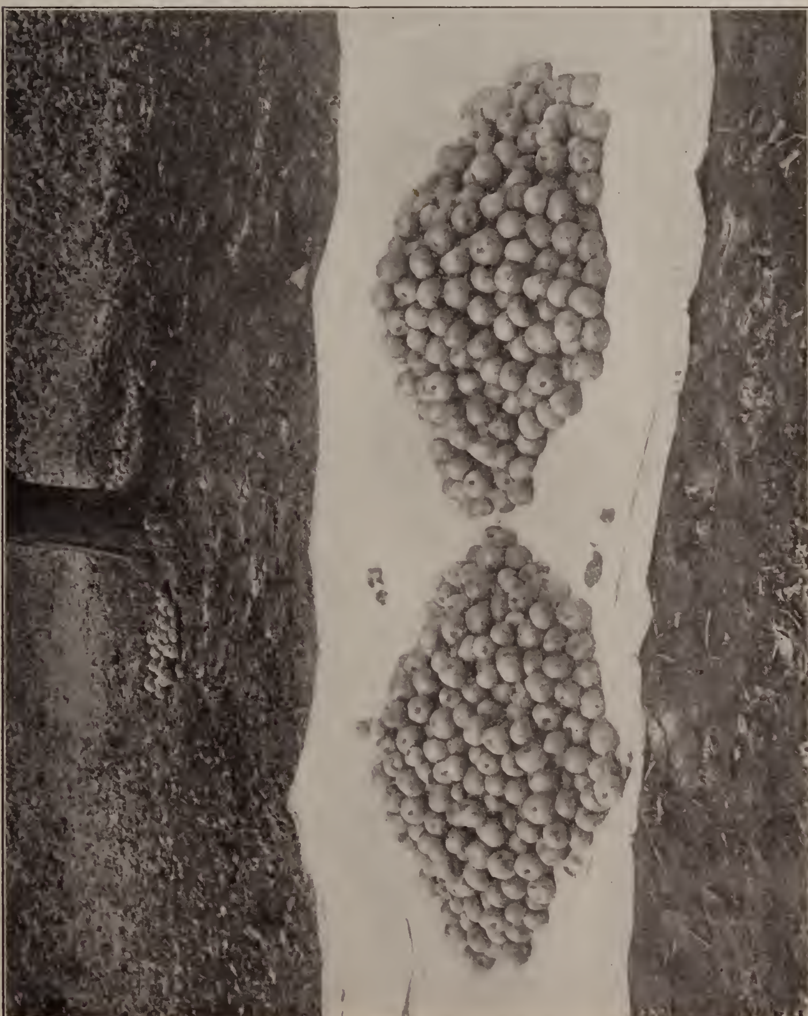


Fig. 21.—Unsprayed apples from Station orchard. On left codling moth and curculio injury and those badly affected by fungus, 51 per cent.; on rght free from worms but also slightly affected by fungus.

Fig. 22.—Kent County orchard, sprayed apples. Wormy 14 per cent.; not wormy 86 per cent.

Fig. 23.—Unsprayed fruit in Kent County orchard. Wormy 62 per cent. Not wormy 38 per cent.

Fig. 24.—Sprayed fruit from Charles County (La Plata), orchard. Wormy frut 5 per cent.; not wormy 95 per cent.

Fig. 25.—La Plata orchard, unsprayed fruits; 42 per cent. wormy, 58 per cent. sound.

fruit from the sprayed trees was nearly twice that from the unsprayed trees. Figures 24 and 25 show results in this orchard.

DEMONSTRATION ORCHARDS.

On account of the desire of many fruit growers in the State, especially those who own only small orchards, to see for themselves the effect of spraying for the codling moth, this department has deemed it desirable to spray orchards in different counties so that as many persons as possible might observe the effects.

Heretofore, however, this spraying has been done on private farms where conditions were favorable for experimental as well as demonstration work.

During the past season, in order to extend this work still further and to reach more farmers, arrangements were made, not only with several owners of favorably situated private orchards who were public spirited enough to recognize the importance of the work, but also with the Boards of Control and Superintendents of several of the county almshouse farms, to allow spraying demonstrations to be conducted in the orchards under their management, and to assist in the same.

The general plan for procedure was to set a date for the spraying, make all necessary arrangements, and invite all parties in the community who were at all interested to be present. The trees would then be sprayed and special points regarding methods of spraying, spray solutions and the object of the spraying would be explained so far as possible by the member of this department present. The visitors were then invited to inspect the orchard at intervals during the summer, comparing the appearance of the trees and fruit which had been treated, with that of those untreated.

In the fall a date would be set for the picking, and interested persons again invited to be present. Here the comparisons were made and the actual benefit accruing from the effect of the sprays shown the visitors.

In no case did this fail to convince the most skeptical that spraying was of great value to any fruit grower, and these demonstrations may be considered among the most potent means of spreading information on the subject.

These demonstrations were conducted in the orchards on the almshouse farms of Kent, Wicomico, Worcester, Frederick and Washington counties, and on the private farms of Mr. Jos. Cowden at Perryville, Cecil county; Mr. W. L. Amoss at Fallston, Harford county; Mr. J. W. Gray at Port Tobacco, Charles county.

The results obtained in each instance were very satisfactory, even though it was possible in most cases to make only one application.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 143. FEBRUARY, 1910.

CONTROLLING FUNGOUS DISEASES.

By J. B. S. Norton and Alvah J. Norman.

INTRODUCTION.

This bulletin contains first an account of recent spraying experiments with lime-sulfur and other fungicides, and also a general account for practical use, of the best method of controlling fungous diseases, especially by spraying with Bordeaux mixture, and is supplemented with a "Spraying schedule" giving in the briefest manner the recommended treatment for the most common diseases and insect pests of Maryland crops.*

PART I.

PROGRESS REPORT ON SPRAYING EXPERIMENTS.

During the past two years this Experiment Station has been conducting some tests of various spray mixtures to determine their value, and also to compare them with the standard fungicide, Bordeaux mixture, to learn if any of them were as effective in controlling diseases or would cause less injury to the plants sprayed.

It is commonly known that Bordeaux mixture may cause some injury to both fruit and foliage of most trees and with but few exceptions will cause serious loss when used to control peach diseases.

Since one of Maryland's chief orchard crops is peaches, and the loss from peach rot and other similar diseases is so great, further reasons for making the investigations herein recorded are unnecessary.

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*The greater portion of the bulletin has been prepard by Mr. Norman but the planning of the experiments and the revision of the manuscript has been done by the undersigned. All statements concerning insecticides have been authorized by the Station Entomologist, T. B. Symons, who has prepared that part of the spraying schedule pertaining to the treatment of insect pests. Valuable suggestions from members of the horticultural staff of the Experiment Station are also acknowledged. E. P. Walls who was Assistant Pathologist at the time the experiments were planned superintended the spraying in each experiment until his resignation in June, 1908. He has supplied the notes on the work up to that time, especially on the comparison of different methods of making the lime-sulfur mixture and from the different brands of lime. Mr. Norman finished the work of that year and has done nearly all the work of the succeeding year herein reported.

J. B. S. Norton.

SELF-BOILED LIME-SULFUR.

In 1907, Mr. W. M. Scott of the United States Department of Agriculture in experimenting to find a sulfur compound that could be effectively used as a summer spray, obtained very encouraging results from the use of the wash known as the self-boiled lime-sulfur mixture. In Circular No. 1, of the Bureau of Plant Industry, he says: "The mixture that gave the most promising results (in the middle west) was composed of ten pounds of sulfur and fifteen pounds of fresh stone lime to fifty gallons of water, and may be prepared as follows: Place the lime in a 50-gallon barrel, and pour a two or three-gallon bucket of boiling water over it. Immediately add the sulfur and another bucket of hot water. The heat from the slaking lime will boil the mixture violently for several minutes. Some stirring is necessary to prevent burning and more water should be added if the mass gets too thick to stir, but the cooking is more effectual when the minimum quantity of water is used; usually from six to eight gallons being required. A piece of old carpet or gunny sack thrown over the top of the barrel helps to keep in the heat. The boiling will continue from twenty to thirty minutes, depending upon the quality of the lime. When the boiling ceases, dilute with cold water to make fifty gallons, stir thoroughly and strain through a sieve of about twenty meshes to the inch, in order to take out coarse particles of lime, but all the sulfur should be carefully worked through."

As soon as it was learned that good results from such a spray mixture were possible, preparation was made at once to test it under Maryland conditions, knowing that if it proved successful, it would be a boon to Maryland peach growers who were suffering great loss nearly every year from the brown rot (*Sclerotinia fructigena*), spraying for which by the ordinary grower had never heretofore proved successful.

EXPERIMENTS IN 1908.

Arrangements were made to test the mixture at several points, which would be representative of the prevailing conditions in each section of the State. The Experiment Station orchard was used as representative of Western Shore conditions. For the Eastern Shore, experiments were conducted in the orchard of Mr. David Walls, at Barclay and of Dr. Foster Sudler, at Sudlersville; while its action under mountain conditions was sought by experiments in the orchards of Mr. A. L. Towson at Smithsburg.

Since Mr. Scott's experiments were conducted in Missouri and Arkansas, where the humidity is not so great as in Maryland, it was thought best to reduce the quantity of lime and sulfur used, lest there be injury to the foliage. The formula by which the mixture was prepared for the 1908 experiments was the 10-5-50, meaning that each ingredient in Mr. Scott's formula was reduced five pounds, or ten pounds of lime and five pounds of sulfur were brought together in each 50 gallons of water.

VARIATION IN MIXTURE.

Samples of lime were requested from a number of different dealers, in order that tests might be conducted to ascertain if different brands would give mixtures of different composition. It would seem that the chance for injury by the mixture depends largely on the amount of sulfids contained, the amount of sulfids being dependent in turn upon the amount of cooking. Since the cooking is dependent upon the heat evolved in the slaking of the lime, it would be apparent that the per cent. of sulfids is not governed so much by the composition of the lime as by the slaking. Also the importance of keeping the mixture well stirred during the boiling should be kept in mind. If not properly agitated during this time, such portion of the sulfur as is in direct contact with the slaking lime appears to be converted almost entirely into sulfids, while that which is more remote from the hot lime, is not acted upon to so great an extent. By proper stirring almost every particle of sulfur can be brought into contact with the lime, thus giving a more equalized action.

The results of the tests of various limes is given in the table below. The amount of sulfids was determined by the specific gravity of the final product. In each case (except No. 2), the amount of lime used was one pound slaked with 500 c. c. boiling water. The amount of sulfur used was one-half pound. This was brought up to three gallons volume with cold water. A cylinder of this was filtered off for the determination of the specific gravity.

Example No. 2, contained only five-eighths pound of lime, and five-sixteenths pound sulfur, to which 312½ c. c. boiling water was added for slaking, and made up to fifteen pints volume with cold water.

No. of sample	Dealer	Brand	Specific gravity
1	M. J. Grove Lime Co., Lime Kiln, Md.	Famous Fred. Co. Lime...	1.003
2	Tabler Lime and Stone Co., Frederick, Md.	Dark Lime...............	1.000—
3	Tabler Lime and Stone Co., Frederick, Md.	Quarry No. 3 (A)	1.002+
4	Tabler Lime and Stone Co., Frederick, Md.	Quarry No. 3 (B)..........	1.001+
5	Tabler Lime and Stone Co., Frederick, Md.	Quarry No. 4 (A)..........	1.003+
6	Tabler Lime and Stone Co., Frederick, Md.	Quarry No. 4 (B).........	1.002

As indicated before, the amount of sulfids may vary in mixtures made in as nearly the same way as practicable, and with the same materials in the same amount. Perhaps the best way to determine the strength is by the color of the settled solution.

SPRAYING IN THE EXPERIMENT STATION ORCHARD.

The heavy crop of plums that had set on the trees in the Experiment Station orchard gave a very good opportunity to test the mixture in the control of the brown rot of plums. This orchard is planted with a number of varieties, and in order to test the mixture on as many of them as possible, every other row crosswise of the varieties was sprayed, applying the mixture to four rows. The first application, was made April 29th on a bright warm day, a few days after the petals had fallen. The spraying was done with an Eclipse barrel spray pump, using Vermorel nozzles. No injury whatever was noted to fruit or foliage after this first spraying. The spray mixture was so adhesive that it seemed unnecessary to make a second application before the 8th of June, when the spraying was repeated. Examinations were made from time to time to determine if any injury to the fruit or foliage had resulted from the spraying, but in no instance was the lime-sulfur found to be injurious. As the mixture seemed to adhere so firmly to both fruit and foliage it was thought that another spraying would hinder the sale of the crop, so no further applications were made.

The results of the spraying as regards its effect on the fruit is given in the table below. Upon the foliage, the spray seemed very beneficial in that it caused the leaves to retain a healthier and darker color and remain longer on the trees.

The results from sprayed trees.

No. t rees	Variety	No. good fruit	No. rotten fruit	Per cent rot
4	Abundance	5540	50	.9
2	Engre	1210	24	1.9
4	Kerr	4900	17	.3
1	Shiro	2850	52	1.8
1	Nona	650	143	18.0
1	Dunlap	2865	359	11.1
1	Mrs. Cleveland	3445	158	4.3
Total from 14 trees		21460	803	3.7

The results from unsprayed trees.

No. t rees	Variety	No. good fruit	No. rotten fruit	Per cent rot
5	Abundance	15465	179	1.1
3	Engre	75	22	22.7
6	Kerr	5040	249	4.7
1	Shiro	5500	1015	15.6
2	Nona	825	359	43.0
1	Dunlap	1813	316	14.8
1	Mrs. Cleveland	2501	754	23.2
16	Other Trees	20590	3718	18.0
Total from 35 trees		51809	6612	13.0

From this table it will be seen that there was about nine per cent. less rot on sprayed than on unsprayed trees. In getting this data, all plums showing any rot were counted every day or two and removed from the tree. Any that had fallen to the ground were likewise removed. This practice no doubt lessened the per cent. of rot on both the sprayed and unsprayed trees, but owing to the fact that the fruit had not been thinned, and the necessity of keeping an accurate count, it was deemed best to remove the diseased fruit at short intervals.

The lime-sulfur mixture was tested in a small way on peaches and apples in the Experiment Station orchard, but it was carried on in connection with mixtures containing kerosene, similar to those used by Close (Delaware Bulletins 68, 73); the kerosene in these preparations helped to spread the mixture more uniformly over the tree. The results showed that kerosene added to the lime-sulfur mixture would in the hands of a novice make a rather dangerous spray. While the limoid used would take up the oil and make a good mixture, without perfect agitation there was inequality enough in the amount of oil discharged at the beginning and end of spraying that in the six tests made one or two trees received much more of the kerosene than others, with serious consequential results. In these tests, one row sprayed with pure lime and sulfur showed no injury, but a more healthy leaf growth. The trees bore very little fruit, so there was no test of its effect on rot. The sprayings with mixtures of lime and sulfur with varying amounts of kerosene and limoid controlled well the surface fungi of apple and scab of peach.

At the Experiment Station further tests of the self-boiled lime-sulfur mixture were made on various vegetable crops. Tomatoes, cabbage and onions were sprayed, while still in the hot-bed with slight injury to the tomatoes only. In addition to these, peas, celery, sweet potatoes, strawberries, tomatoes, asparagus and canteloupes were sprayed, chiefly to ascertain whether injurious effect would ensue.

With the exception of the canteloupe, no damage could be noted on any of the plants sprayed, and slight if any benefit could be noted by the control or prevention of disease, but in no case were diseases at all destructive. With the canteloupe, the lime-sulfur spray seemed quite injurious. Many of the older leaves were seriously injured, some even being entirely killed. The plants were quite badly affected with blight, but the unsprayed plants were in much better condition than the sprayed.

SPRAYING TESTS AT SMITHSBURG.

In the peach orchard of A. L. Towson at Smithsburg, the self-boiled lime-sulfur mixture was tested under commercial conditions. The first application was made by Mr. Walls, May 1st, before the blossoms were shed. Fox Seedling, Ford Late, and Elberta were the varieties sprayed. The second application was made on June 20th by Mr. Towson, and preparation was made to spray again early in

July, but the mixture from the earlier spraying was adhering so firmly to the fruit that there was some fear, lest its presence on the fruit would interfere with its sale, consequently only the two applications were made. There was evidence that the first spraying was very effective in preventing an early attack of rot. Mr. Towson has been very successful in controlling peach rot with Bordeaux mixture, but the lime-sulfur showed equal efficiency, in that only three peaches rotted on the thirty-five trees sprayed, and there was a marked difference in the prevalance of scab or black spot on sprayed and unsprayed trees. The following statement from him, well sums up the results of the test:

"As regards this self-boiled lime-sulfur, it is probably an excellent thing, and the safest for the public generally to use; but results of one year's spraying in my orchard have not made me change to it from Bordeaux mixture. There are several disadvantages in the self-boiled lime-sulfur; each time the tank comes to be refilled, a new supply has to be made, taking valuable time, and it is a disagreeable job to be slaking lime in hot weather. Furthermore, it sticks to the peach so well that we had to rub it off at ripening time, which adds greatly to the expense of harvesting."

TESTS AT SUDLERSVILLE AND BARCLAY.

At Sudlersville, a portion of the plum orchard of Dr. Foster Sudler was given two sprayings, the first on May 7th and the second May 29th. These trees had been excellently cared for, and were well filled with fruit, but thinning had not been practiced nor the rotted fruit removed as at College Park, and a much larger percentage of the fruit rotted. While the rot was not controlled, an approximate count showed seventeen per cent. less rot on the sprayed than on the unsprayed trees, and the sprayed trees had generally a better appearance and darker green foliage.

At Barclay, a number of crops were sprayed in the orchards, and gardens of Mr. David Walls, and on the adjoining farm of A. R. Butler, but owing to the prolonged dry weather the experiments were dropped on all but the apple and peach. Plats of both apple and peach were sprayed four times: April 20th, May 4th, May 30th and July 10th. In the case of the apples, the results showed considerable benefit. Leaf diseases were controlled to a reasonable extent, and the prevention of diseases on the fruit was very marked. In the case of the peach, more definite results were obtained, as a count of the rotted and perfect fruit was made. The following is the result of the count:

34 Sprayed trees gave 11% of rot.

7 Unsprayed trees gave 14½% of rot.

The effect of the spraying was also noticeable in the way the fruit on sprayed trees hung to the tree and in most cases the sprayed fruit was larger than the unsprayed. There seemed to be little if any benefit from the last spraying. One quince tree on A. R. Butler's

farm sprayed twice (April 20 and May 30th) showed almost absolute freedom from the leaf spot, as compared with adjoining unsprayed and badly spotted ones.

As regards the results of the test Mr. David Walls says: "In my opinion the self-boiled lime-sulfur is an effective fungicide. The results on peach were gratifying, the fruit hanging on the trees much better where sprayed than on unsprayed trees, and the loss from rot being lessened. On apple the rot was materially diminished by spraying. Also on these trees the fruit held on well, until maturity. On grape and Kieffer pear, while no material benefit seemed to be derived from the spraying, there was no injury to either fruit or foliage from the spray mixture. Where a fungicide is to be used in only small quantities, and where the farmer is not well versed in the making of spray mixtures, I believe a mixture more nearly in keeping with the proportions mentioned in the formulæ, is more easily obtained in the case of self-boiled lime-sulfur than of Bordeaux mixture."

During the year, a few minor tests of the lime-sulfur spray on vegetables and small fruits were made at Barclay and in a number of other places over the State, but owing to the extreme dry weather and consequent reduction of disease injuries, there was no opportunity to get results either favorable or otherwise except that no injury resulted from the use of the self-boiled lime-sulfur wash.

SUMMARY.

To sum up the results of the 1908 experiments with the self-boiled lime-sulfur, it can be said that the mixture, with few exceptions, was entirely safe to use even on very tender foliage. If instructions are followed no one need injure the fruit or foliage by using this mixture, at least under the conditions of this year's test.

From the evidence gained in one season's work, the lime-sulfur mixture will not absolutely control peach or plum rot, but it will lessen the injury from the rot fungus. It is reasonably effective in the control of leaf diseases and in all cases where opportunity was given to test its effect on black spot or scab of peach (*Cladosporium*), it proved almost entirely preventive.

From the economic standpoint, lime-sulfur will not compare favorably with the standard Bordeaux mixture. The disagreeable features in its preparation and the necessary loss of time which adds greatly to its expensiveness are both items of great importance and will be against its use except on plants of very tender foliage, such as peach.

EXPERIMENTS IN 1909.

At the beginning of this season the plan of the experiments was slightly changed. It had been learned that the lime-sulfur mixture was entirely safe to use, but the question to decide was whether it was an economical spray. To determine this, arrangements were made to conduct a comparative test of the self-boiled lime-sulfur and

the standard fungicide, Bordeaux mixture. At the beginning of this season the B. G. Pratt Company, brought out their commercial preparation, Sulfocide, and on being asked to test it, it was added to the experiments with the other preparations.

The late frost in the spring of 1909 destroyed all the peaches and plums in the Experiment Station orchard, so no test was made at College Park. Through the kindness of Mr. E. W. Hungerford of Charles county, we were permitted to make the comparative test in his orchard at Marshall Hall, and Mr. E. P. Cohill, of Hancock, offered a portion of his orchard for the test. These two tests were all that were made.

PREPARATION OF THE MIXTURES.

A slight change was made in the self-boiled lime-sulfur wash in an attempt to overcome its tendency to adhere so firmly to the fruit. Instead of having an excess of lime, the quantity of sulfur was increased. The formula as used, was 10-10-50. It is prepared as follows:

Mix ten pounds of sulfur with a small quantity of water until the sulfur is thoroughly moistened; to this add water to make a thin paste, and then add ten pounds of good quick lime. While slaking, add more water as needed. The heat thus produced is sufficient to form a very small amount of sulfids, but not enough to injure foliage. Upon cooling, the mixture has a yellowish white color, and the lime and sulfur being in such a finely divided state, can, when water is added to make fifty gallons, be readily strained through doubled window screen wire into the spray tank.

Two strengths of Bordeaux mixture were used, 4-5-50 and 2-6-50, the latter being used on peach. Bordeaux mixture was made as described later in this bulletin.

Sulfocide is a soluble sulfur compound, containing a very large percent of sulfur. The manufacturers recommended using it at the strength of one gallon to seventy-five gallons of water; being a liquid with no precipitate, it is an easy preparation to apply.

SPRAYING TESTS AT MARSHALL HALL.

In the orchard of Mr. E. W. Hungerford, tests of the three mixtures were made on peach, plum, pear and apple. The first application was made on April 12th and 13th. A barrel pump was used with the Bordeaux type of nozzle. At the time of the second spraying, on May 17th, no injury could be noticed as resulting from the earlier spraying. The application at this time was made in the same way, and the trees were quite thoroughly sprayed. The effect of this spraying as noted a few days later, was very injurious to the peaches, except in the case of the lime-sulfur mixture. Sulfocide at 1 to 75 was very much too strong, causing a total loss of leaf surface and fruit on the peach trees sprayed. Bordeaux mixture of the 2-6-50 formula, like-

wise proved very injurious to peaches. In this case it might have been due to the materials used. On the other trees, no damage was noted from the use of the self-boiled lime-sulfur or Bordeaux mixture. The Sulfocide was too strong even for apples, but the damage was slight compared to the damage on the peach.

No further spraying was possible, and owing to the very dry season, scarcely any benefit could be noted from the use of either spray mixture at the time of taking final notes.

SPRAYING TESTS AT HANCOCK.

The tests of the three spray mixtures in the orchard of E. P. Cohill at Hancock, were conducted on the same plan as those at Marshall Hall. The same mixtures were used and were prepared in the same way. Here, however, the tests were made only on seven-year-old apple trees, and the mixtures were used on rows side by side, giving a better opportunity for making comparisons. Each row contained twenty-six trees. Two of the rows were of the Jonathan variety, one was Winesap and the check row was York Imperial and Winesap mixed.

The spraying material was applied from a large tank by means of a hand pump of the horizontal type, with which a pressure of approximately 100 pounds was maintained. Because of their greater capacity, Bordeaux and Mistry Junior nozzles were used for most of the work, replacing nozzles of the Vermorel type. The trees in all cases were sprayed until every leaf was well moistened.

The first application was on April 26th, 1909. Weather conditions were fine, sunshiny and warm. Sulfocide being entirely liquid, was the easiest to apply, while the lime-sulfur, owing to the precipitate, was the most disagreeable. At the time of this spraying, the buds were just beginning to show color. This orchard is very free from all fungous troubles, hence, when notes were taken, May 24th, results were very much the same for each spray mixture. The lime-sulfur was not much more adhesive than the Bordeaux, and if any mixture showed an advantage at this time, it was the lime-sulfur, because of the denser darker foliage on the row so sprayed. On this date a second application of the same materials was made under very much the same weather conditions. The blossoms had all fallen and the sepals were just beginning to fold in. No arsenical was used except with the Bordeaux mixture. Thorough spraying with the self-boiled lime-sulfur, leaves a tree very white, and it is an easy matter to tell whether or not the tree has been perfectly sprayed. Sulfocide makes very little show on the trees, and it is difficult to determine when the tree has been perfectly sprayed.

On July 2d the trees were again examined. At this time the edges of many leaves on the trees sprayed with the Sulfocide were burned, but there seemed to be no harmful effect on the fruit, as none had fallen. This spray did not control the apple leaf spot, which was quite abundant, but it did have a deterrent effect on aphis and leaf-

hoppers. Lime-sulfur was an apparent benefit to the tree as the foliage was darker in color and more dense but it did not control or prevent the leaf spot. Bordeaux mixture showed considerable fruit injury, but not such as would greatly detract from its appearance; it did not completely control leaf spot, but prevented much of it. It was desired to spray again on this date, but unfortunate circumstances prevented; so only two applications were made. On August 9th notes on results were again taken when marked differences could be noted in the value of the mixtures. Sulfocide failed to control leaf spot and compared with the check, it showed no value whatever. Lime-sulfur also failed to control leaf spot, but it seemed to produce a healthier and better colored foliage. The Bordeaux still showed considerable fruit injury, but the leaves were clearer and brighter with but a few scattering cases of leaf spot.

On September 21st, final notes were taken and a count of fruit made. Since August the fruit spot caused by a fungus, which Dr. Charles Brooks identified as *Cylindrosporium pomi,* had made its appearance with almost disastrous effect, as shown by the table. The extreme drouth of the season, undoubtedly reduced the injury from various fungi.

The following table will show the benefit derived from two applications of each mixture:

Spray mixture.	Variety.	No. of trees counted.	Fruit on ground.	Diseased fruit on trees.	Perfect fruit on trees.	Per cent. perfect fruit.	Condition of foliage.
Sulfocide	Jonathan.	5	12	77	45	34	Badly spotted.
Lime-sulfur	Jonathan.	5	28	113	88	39	Better color, but much leaf spot.
Bordeaux	Winesap.	4	10	10	314	95	Clean, very little disease.
Check.........	Winesap and York Imperial.	5	20	40	108	65	Not so healthy, scab and leaf spot present.

The large percentage of good fruit on the check row is due to the fact that one-half of the check row trees were Yorks, and they are much more resistant to the fruit spot disease than the other varieties. The Winesap trees in the check row showed as large a percentage of diseased fruit as was found on the Jonathan trees.

SUMMARY.

The tests made show Bordeaux mixture to be much the better fungicide of the three, even though it may cause injury of the apple fruit and cannot be safely applied to the more tender plants such as the peach.

Sulfocide, while a very easy mixture to apply cannot be safely used at a strength greater than 1 to 150 or 1 to 200. At this strength or even at 1 to 75 it did not prove, during one season's test, to be effective in the control of fungous diseases.

Self-boiled lime-sulfur when made from ten pounds of lime and ten pounds of sulfur to fifty gallons of water was not nearly so adhesive as when less sulfur was used. The mixture in either case is very disagreeable to apply, and while adding to the general healthy appearance of the tree, it was not effective in controlling plant diseases, though in some seasons it may greatly reduce the amount of damage from them.

To sum up the chief characteristics of the three mixtures it can be said:

Sulfocide is the easiest and most agreeable to apply.

Self-boiled lime-sulfur is the safest to apply from the standpoint of plant injury.

Bordeaux is the most economic mixture to apply, in that it gives the largest percentage of marketable fruit.

LIME-SULFUR FOR PEACH LEAF CURL.

The home-made and concentrated lime-sulfur washes now generally used in spraying for San Jose scale have been recommended previously by this Experiment Station as fairly good preventives of peach leaf curl, which is often a serious disease in late spring in Maryland, especially on Elberta and a few other varieties.

The statements previously published can be augmented by the results of a careful examination made by the Station Pathologist and Entomologist of many orchards in different parts of the State in May, 1909. Although most of the orchards seen had been sprayed in the late winter with either home-made or concentrated lime-sulfur solution, a number of cases of isolated unsprayed trees badly affected with leaf curl were found which might be taken as checks. Very little difference was noted in the effect of home-made and factory-made washes upon the curl. Several orchards sprayed with the latter had no curl, while others had considerable.

The only case where trees had been sprayed without good results on the leaf curl was in an orchard overlooking the bay near Cambridge, which had, so far as could be ascertained, been properly sprayed with home-made lime-sulfur wash, but in which the young trees had five per cent. leaf curl, and an older orchard near by as much as fifty per cent. In orchards in Washington county, fifty per cent. of curl was seen on unsprayed Elberta and only five per cent. in adjoining orchards of Elberta sprayed with home-made lime-sulfur wash. A little curl was noted on unsprayed Salways, none on sprayed.

Inasmuch as the use of lime-sulfur for control of scale is now generally practiced, it is therefore the most practical treatment for leaf curl; however, 4-5-50 Bordeaux mixture applied before the buds swell is generally considered a better treatment.

A Power Sprayer in Action.

PART II.

MAKING AND APPLYING BORDEAUX MIXTURE.

When an orchardist finds among his trees any trouble of the nature of a disease, his first duty is to find out what the trouble is; second, to ascertain whether there is a remedy for this trouble; and third, to apply whatever remedy may be prescribed, provided there is sufficient evidence that this remedy is, from the commercial standpoint, a success. Any process that requires the expenditure of from five to eight dollars in time and money to save a ten-dollar crop, is an extravagant process. The ideal process for the control of orchard ailments is the one that requires the least outlay in time and money to obtain a crop of the largest money value. Or in other words, the money expended in the

control of these ailments will be the smallest per cent. possible of the gross returns from the crop.

With this idea in view, an attempt will be made to outline the most practical system for the eradication or control of those plant diseases, which are subject to control by spraying.

BORDEAUX MIXTURE.

The most important, the most satisfactory and the most economic remedy for the control of plant diseases in Maryland is Bordeaux mixture. Many other remedies have been tried with a view of finding something that will give more desirable results, but thus far, notwithstanding the fact that Bordeaux mixture has many undesirable attributes, nothing has been discovered that from the standpoint of economy can take its place. Bordeaux mixture is not a cure-all. When properly applied, it will control only those diseases caused by fungous growth in which the parasite is sufficiently exposed as to come in direct contact with the mixture. A disease induced by an organism that grows entirely within the plant tissue seems to be beyond the control of any spray mixture applied to the surface. But, since the spores of most parasites germinate on the surface of the plant before entering the internal tissues, Bordeaux mixture if applied in time will control many of this class of parasites, by killing the spore in its early growth before an entrance into the plant tissue can be made.

Bordeaux mixture is a clear liquid, containing a flaky gelatinous precipitate, which when held in suspension, gives the whole mixture a light blue color. It is composed of a number of chemical compounds, which are formed when dissolved bluestones and slaked lime are brought together. The number and composition of these chemical compounds may vary with the methods of preparing and quantities of each ingredient used. Because of this varying in composition, it is admitted that Bordeaux mixture is as yet somewhat of an unknown quantity, and it is possible, when more is known, that it may become a still better fungicide.

METHOD OF MAKING.

Bordeaux mixture has been made in many different ways, but to make its preparation as plain and simple as possible, only one method will be given. This method can be followed, no matter which formula is used.

For use on apples, pears and other hardy leaved plants, the formula *4-5-50 has given excellent results. This formula means that four pounds of copper sulfate or bluestone; five pounds fresh lump lime and fifty gallons of water are combined in making a barrel of the

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*Whenever a formula is written in this way, the first figure gives the number of pounds of bluestone to use; the second the number of pounds of fresh lump lime; and the third the number of gallons of water.

mixture. For making the mixture, the following method has, from the standpoint of results, proved the cheapest, quickest and easiest.

When only a small quantity of the mixture is to be made, place four pounds of the bluestone in a wooden vessel and add two gallons of boiling water. Bluestone dissolves rapidly in hot water, but quite slowly in cold water. If there be plenty of time the bluestone can be dissolved by placing it in a small sack and hanging it just beneath the surface of the water in a wooden or stone vessel, allowing it to remain there over night. These precautions are necessary: First, because bluestone, if placed in the bottom of a vessel of water, will slowly dissolve until the water on a level with and below it becomes saturated, and though there be plenty of water above, no more will go into solution, hence the importance of hanging at the surface of the water. Second, bluestone in solution acts rapidly on most metals with which it may come in contact, and destroys them in a very short time. The safe practice then is to use only stone or wooden vessels. Bluestone has been known to destroy in one night a new galvanized pail in which it was being dissolved, causing a total loss of the contents.

After the bluestone has been made ready, place five pounds of lump lime of best quality in a tight box or tub and add water slowly, allowing the lime to completely slake without burning, until the lime is in a thin paste. It is always best to have water available under pressure so there will be no necessity for carrying water by hand. When the ingredients are ready, bring up the spray barrel, which has been thoroughly washed out, and fill about three-fourths full of water. When sufficient water has been placed in the barrel, add the bluestone solution. It is best to add the bluestone after the water has been placed in the barrel, for then the bluestone will almost instantly mix itself with the water, forming a very dilute solution. Now, it is time to add the lime. If the water is clear and contains no leaves or lint, there is no need of using a strainer thus far, but as the lime must be strained, it is well to run all the ingredients through the strainer. The lime paste is slightly diluted and poured into the strainer. If well slaked, it can be readily washed through the strainer with the water required to fill the barrel. With a few strokes of the spray pump for stirring, the mixture will be ready to apply.

This method of making Bordeaux mixture is slightly different from that usually advocated, and before these differences can be explained, it will be necessary to give some of the ideal conditions sought in making it. The most desirable mixture is one that will adhere firmly to the parts of the plant sprayed, that will cause the least amount of trouble in the way of clogging nozzles, that will remain in suspension as long as possible, and one that is easily and simply prepared. Three of these conditions can be fulfilled by getting the precipitate in the most finely divided condition possible, and the above method comes the nearest to fulfilling all conditions. By getting the bluestone in a very dilute or finely divided condition, a very small amount of bluestone will come in contact with a particle of lime, and as a consequence, the

size of the particles of the precipitate formed on adding the lime will be very minute, and will vary in size, as the bluestone solution is more or less dilute. It would be possible to get quite similar results by adding a stronger solution of bluestone to a very dilute milk of lime. This change can be readily adapted to the method described.

In making Bordeaux mixture, care must be exercised that the materials used are pure and of good quality. It is hard to detect impurities in bluestone, and consequently the safest policy is to buy a product made by a manufacturer, whose reputation is above question. There is no law at the present time governing the sale of spray mixture ingredients as regards purity, consequently there is no protection given the consumer. The danger in using impure bluestone is in the effect the impurities may have on the foliage. Oftentimes a severe injury to the leaves and fruit will result.

For the other ingredient in Bordeaux mixture, nothing better than ordinary lime has been found, and nothing else is as economical. The bluestone is the element that gives the mixture its fungicidal properties, while the lime is used only to prevent the copper compounds from injuring the fruit and foliage. A slight excess of lime is necessary so as to be sure that all the soluble copper has united with the lime. Lime has the additional advantage of combining with the bluestone into a fine precipitate that sticks well to the leaves even through rainy weather. The quality of lime is very variable. One can be reasonably sure that the lime is all right, if after slaking, there be but a small quantity of, or better not any, sand or unslaked sediment remaining. In no case can air-slaked lime be most successfully used.

When making Bordeaux mixture, it is usually well to add a poison to kill the leaf-eating insects. Paris green is recommended as the cheapest poison to use, and experience shows that it gives very good results. Except in special cases, one-third of a pound is sufficient for 50 gallons of Bordeaux mixture, and should be added just after the lime; the whole mixture being thoroughly stirred.

As has been said, Bordeaux mixture made after the 4-5-50 formula will give satisfactory results when used on plants which have rather hardy foliage; but with plants having a more tender foliage, as the peach and some of the plums, a different formula should be used. Some recommend a 3-9-50 formula, but that seems rather strong for peach foliage in Maryland. Judging from our experiments and observations, a mixture stronger than one made from the 2-6-50 formula could not be recommended. This has been very successfully used by some growers in controlling peach rot. In other cases, we have known peach foliage to be injured at this strength. Great care must be exercised in making the mixture and first-class lime used. Those who have never used it, should first test it on one tree. A still stronger mixture should be used on some crops. A mixture made from the 6-5-50 formula has been known to control grape rot, when weaker solutions would not. This stronger formula should be used in spraying potatoes.

STOCK SOLUTIONS.

When larger areas are to be sprayed, and a number of barrels of the mixture are required, arrangements can be made whereby less time will be lost in preparing the mixture. When available, a number of barrels can be provided for stock solutions, but if these must be bought outright, one or two will be sufficient.

By stock solutions, it is meant that a quantity of either ingredient can be prepared in a more or less concentrated form, that will keep indefinitely and can be used from as needed. By such a provision, much time can be saved in preparing the mixture, and in many cases a better mixture will be made.

In making a stock solution of bluestone, place a fifty gallon barrel in such a position that it will be within easy reach of the wagon, that is to be used for spraying. A platform, level with the spray tank or barrel will, if available, be most convenient. Fill with about 45 gallons or any desired quantity of water. Weigh out three pounds of bluestone for each gallon of water, and suspend in a good strong sack that will not lint, just beneath the surface of the water. For 45 gallons, use 135 pounds of bluestone. This amount will make 24 barrels of Bordeaux mixture, using one and one-third gallons of the stock solution for every 50 gallons of the mixture. Under normal conditions only three and one-third pounds of bluestone can be dissolved in one gallon of water, this amount making a saturated solution.

A saturated solution is the ideal stock solution, because it contains the largest amount possible of bluestone per gallon, consequently a barrel of it would go farther than a like amount of a weaker solution. Also, in case any of the liquid evaporates, the bluestone will be deposited along the sides and bottom of the barrel as crystals, leaving the remainder of the liquid in a saturated condition, thus eliminating any need of stirring or danger from a change in the strength of the solution. Where weaker solutions are used, evaporation tends to make the solution stronger, and as bluestone naturally settles until the lower strata become saturated, there is danger that a mixture made from a weaker stock solution will be either too weak or so strong that serious injury will result. Where a stock solution of one pound to the gallon has stood over night, though the depth of the solution was only two feet, the liquid at the surface when tested showed 3½ per cent. less bluestone than the mixture nearer the bottom. However, owing to the difference in the water used in the various parts of the State, the quantity of bluestone required for a saturated solution would vary so greatly that a solution of three pounds to the gallon will give more satisfactory results. Two barrels are needed for stock solutions, one to be using from while the bluestone in the other is dissolving.

In the case of the lime, owing to the rapidity with which it settles when made into a stock solution and the consequent difficulty in getting the exact amount of lime required for each barrel of the mixture, it is best to slake the lime separately for each barrel or tank of the mix-

ture. One or two boxes or tubs, each holding enough for one tankful, would be all that is necessary. The lime placed in the tub with the necessary water, would slake while the previous tankful was being sprayed on the trees. In case, however, it is impossible to obtain fresh lime each time, and to guard against the possibility of using air-slaked lime, it might be well to make a stock solution by slaking a large quantity at a time. By keeping barely covered with water, it will remain in good condition indefinitely. In using, take a quantity equal to that made by slaking five pounds of quick lime.

SPRAYING APPARATUS.

For applying any spray mixture, the more improved the apparatus used, the better will be the results of the spraying. It would not do to recommend spraying apparatus manufactured by one firm more highly than that made by other firms; in fact, in many cases that would be impossible, for while every spray pump has some points of advantage, no one manufacturer's product has all the most desirable features. A spray pump, and by that is meant any apparatus used to apply liquid spray mixtures, is a more or less complicated machine, and while not advocating any one pump, an idea of the important parts of the ideal pump will be given.

Pumps in general, are of two types—the horizontal and the upright or vertical. The horizontal pumps are used chiefly with power sprayers, while the vertical is the usual type for barrel sprayers. The horizontal pump forces the liquid into the air-chamber with every stroke of the plunger, while the upright pump forces the liquid into the air-chamber only with the down stroke of the handle.

ESSENTIAL PARTS OF A SPRAY PUMP.

The essential parts of a spray pump are the cylinder, plunger, valves, air-chamber and nozzles. These parts should receive careful attention from the prospective buyer of any spray pump.

Since the action of copper compounds on metals has been mentioned, it is necessary only to state here, that all the working parts or the parts coming in contact with the liquid should be of brass, or other non-corroding substance. Where the entire pump is submerged in the liquid, it is best to have it made entirely of brass, but as that adds considerably to the cost of the pump, the common iron pump with brass working parts will be found satisfactory.

Taking up the special parts mentioned, the cylinder must be of solid brass or at least lined with brass. This is imperative, because the part through which the plunger works must be non-corroding, otherwise the plunger would stick and cause trouble. The size of the cylinder regulates the capacity of the pump and to maintain a constant pres-

sure, the capacity of the pump must be greater than the quantity of the mixture it is desired to apply per minute. The cylinder must be so located as to be quickly removed, thereby giving easy access to the plunger.

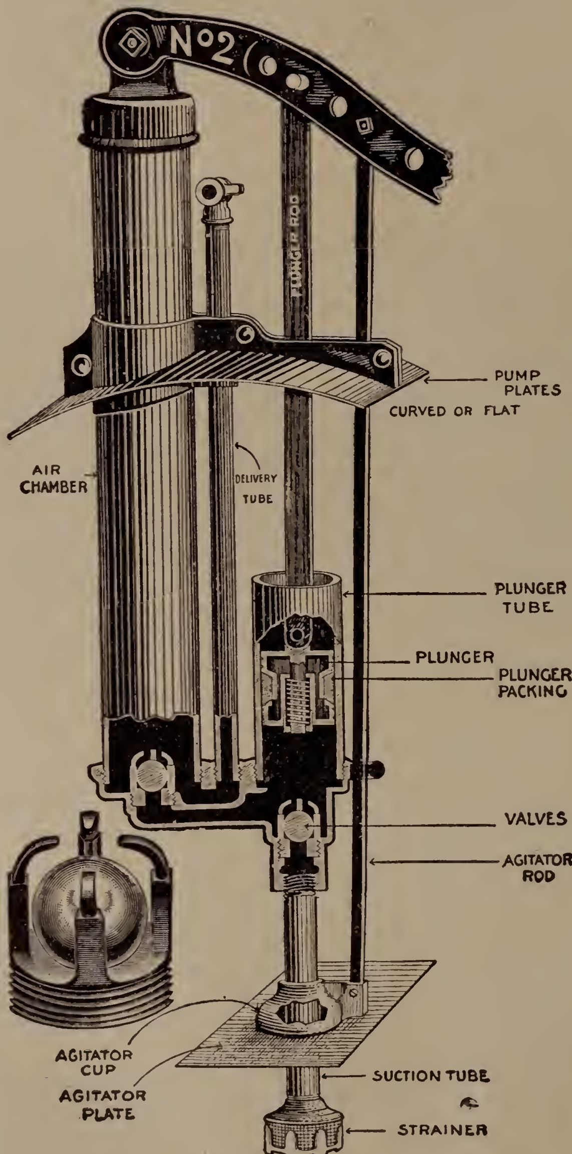

Fig. 1—A desirable type of pump.

An ideal plunger for a vertical pump is one fitted with an automatic adjustment, that is, with the parts so arranged that on the stroke, which forces the liquid into the air chamber, the parts of the plunger are pressed together, forcing the packing against the sides of the cylinder

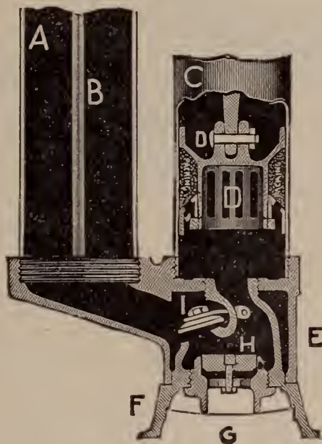

Fig. 2—One Arrangement of the Working Parts of a Pump—A, air-chamber; B, discharging tube; C, cylinder; D, plunger, automatic; E, base of pump; F, detachable valve cage; G, screen; H, cylinder valve; I, air-chamber valve.

until there is no danger of any liquid passing the plunger. On the return stroke, the pressure being removed, the packing settles away from the cylinder walls, lessening the wear on the packing and requiring less force to operate. A plunger could be made without packing, but its cost would be greater, and should it wear unevenly, it would soon be useless. A plunger so constructed and attached as to permit ready examination, and repacking is most satisfactory. In most horizontal pumps, owing to their power of double action, the plunger must be solid and so placed as to be absolutely tight for either stroke.

The valves of a pump, while most important, are perhaps less understood than any other part of a pump. As the pressure maintained depends so largely on the valves, every man who sprays should examine the valves of the pump he uses, so as to know how to get at them in case of need. With the common hand pump and all upright, single action pumps, two valves are required, the air-chamber valve which prevents the return from the air-chamber of the liquid forced into it, and the cylinder valve which prevents the liquid from returning into the barrel on the stroke which forces it into the air-chamber. Both of these valves must be made from a hard non-corroding substance of the same consistency throughout. A pump is worthless for spray purposes in which any kind of packing is used around the valves. The ideal valve gives a smooth hard surface, no one part of which receives more wear than another. One would expect the valve

whose movable parts do not rest at the same point twice in succession to wear the longest. A good valve must not let any sediment of any sort gather around it, and should be so attached that it would be

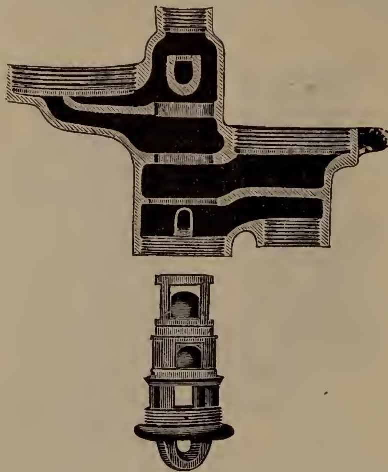

Fig. 3—Duplex Valves—Both valves are removed at the same time, and are at once accessible for examination.

physically impossible for it to rest in any other than the right place. Then, too, a valve to be ideal, must be instant in acting, thus preventing the escape of any liquid before the opening is closed. With the best of valves, something may happen to prevent them from working, thus necessitating an examination. This naturally happens when at work, and at a season when time is money. To make possible quick examination, the valves ought to be so placed as to be almost instantly removable, and they are most ideal when so situated and connected that both can be removed at once.

For the horizontal, double acting type of pump, four valves are necessary. These necessarily differ in shape and location from those used in the vertical pump, but what has been said about the one can be equally well applied to the other.

Whatever the material the air-chamber is made from, it must be able to withstand a higher pressure than that normally used. For a hand pump, a pressure of about 175 pounds to the square inch is sufficient, but for a power sprayer, the air-chamber should be made to withstand a pressure of 275 or 300 pounds. This is necessary even though 200 pounds is all that might be needed, on account of the danger resulting from the over-flow valve becoming clogged. The size of the air-chamber regulates the ease of maintaining a continuous high pressure, and the length of time spraying can continue after pumping has ceased. Too large a chamber must be guarded against, lest the precipitate in the mixture pumped into the chamber settle and result in injury to the plant sprayed.

The last of these more essential parts and one of equal, if not greater importance is the nozzle. Much has been written about nozzles, but only a few of the principles will be briefly stated here. The desir-

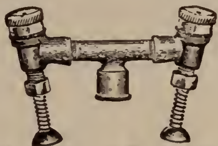

Fig. 4—Vermorel type of nozzle. Gives a good fine spray, but is slow.

able thing in spraying plants for fungous diseases is to apply the mixture in a way to leave the greatest amount of the mixture on the leaves, and at the same time cover the largest area possible. The finer the spray the larger the amount of the mixture that can be left on the tree, but too fine a spray is not conducive to rapid work, and while a fine spray is most ideal, it is physically impossible to cover the entire tree without getting so much on some leaves that it will run off. After the liquid has begun to run on a leaf less can be made to adhere. This is readily seen in the case of rain beating against a window. The window glass will be covered with the largest amount of water at the time just before the drops begin to run. The advisable thing to do then in spraying is to use the finest spray available, which will at the same time cover a tree well in a short time. No matter what the size of the pump, the nozzle regulates the rapidity with which a mixture

Fig. 5—A desirable type; small and compact, with nothing to catch on the limbs; direct and oblique delivery.

can be placed on a tree. No larger amount of mixture can be used than will, under a given pressure, go through the nozzle openings in a given period of time. In other words, the nozzles regulate the expensiveness of the spraying operation. The amount of mixture that is desired to be put on per day, may vary with the purpose for which the spray is being used; but as a basis to work to the statement can be made that a hand pump should deliver through the nozzles from one and one-half to two gallons per minute; while a power pump with two lines of hose should throw from eight to ten gallons per minute.

There is such a great variety of nozzles and they are so different as to construction that it would be out of place to discuss the different types here. Just a few generalities need be mentioned in this connection. The most desirable nozzle is one simple and compact in construction; light in weight and self-cleaning, or if there be any cleaning device, it should not project out in any way so as to catch on the limbs of the tree. A small nozzle that can easily be thrust in among the

limbs of a tree has many points of advantage. A nozzle must be made from a strong, non-corroding metal. The forcing of the liquid through the small opening in the nozzle gradually enlarges this opening. With most nozzles, the cap or the part containing this opening must be frequently replaced. It will mean a considerable saving in money if this part is small and inexpensive. Few, if any nozzles, have sufficient capacity for good rapid work when only one nozzle is used on each line of hose. By using a Y, two or more nozzles can be used in place of one, but care must be exercised in selecting the nozzles, lest the increased weight be too tiring on the operator, or they be too bunglesome in getting in among the limbs of a tree. Some manufacturers have brought out a cluster nozzle, in which from two to ten small nozzles are used; they should be so attached as to throw the mixture at an angle from the main line, so that by simply turning the rod in his hand, the operator can reach both sides of the leaf or branch.

While these are the real essential parts of a pump, there are other parts of greater or less importance, which deserve mention. Among them are the strainer at the base of the pump, which always comes with the pump, and is made of brass wire with 18 or 20 meshes to the

Fig. 6—A Cluster Nozzle—For rapid efficient work, provided a high pressure is maintained.

inch. The strainer through which the liquid should pass before it enters the tank or barrel, can be made at home or it can be purchased from dealers in spraying supplies. A good home-made strainer is made as follows: Make a hopper with sloping sides, the lower end being just large enough to fit into the opening in the barrel or tank. Both ends of the hopper are left open. Into the upper end is fitted another lighter box open at the top with cleats for handles. The bottom of this inner box must be made of wire. Brass wire, 20 meshes to the inch, will be most permanent, but the common window screen wire will do. The wire should be attached so as to have a slope of about 30 degrees. It is very hard to clog a slanting bottom and the inner box being movable if any sediment clings to the wire, it can readily be washed out.

Another usual attachment of spray pumps is, the agitator. This is less important when the mixture is not allowed to stand any length of time or does not contain too heavy a precipitate. All barrel pumps have agitators attached to them, and all large tanks are usually supplied with them. A good agitator is one with a stroke, such that all sediment can be washed from the pump strainer and at the same time

keep as much of the precipitate as possible in suspension. It is also important that the agitator be light and easy to manipulate.

In spraying large trees extension rods are necessary to get the nozzle into the upper parts of the tree. These may be either iron or brass-lined bamboo. The iron rods are much cheaper, and very serviceable. The most serious objection to an iron rod is, its smallness, causing the hands to cramp when using it for any extended period. They will last longer at hard usage than bamboo, but with reasonable care the bamboo will last a long time, and because of its lighter weight and larger size, is much easier on the operator.

Good hose is essential. When wrapped with wire it is stronger, but the wire adds weight. In most cases the couplings are the weakest parts of hose. Extra long couplings when securely attached to good hose will easily withstand a pressure of 200 pounds.

If any orchardist desiring to purchase a pump will examine thoroughly those parts that are of greatest importance, and see to it, that they are capable of doing the work required, he will find it much easier to get a satisfactory pump. In case some growers are not familiar with the names and addresses of dealers in spray pump supplies, a short is list is appended:

E. C. Brown Co., Rochester, N. Y.
Friend Mfg. Co., Gasport, N. Y.
Griffith & Turner Co., Baltimore, Md.
Morrill & Morley, Benton Harbor, Mich.
Spramotor Company, Buffalo, N. Y.

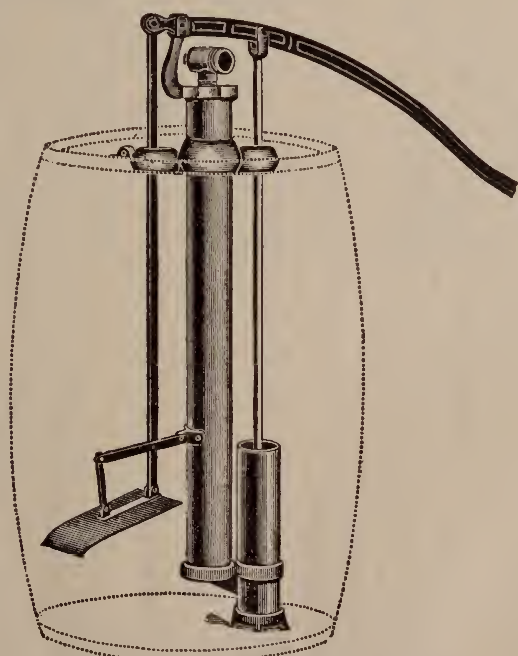

Fig. 7—Barrel pump for end attachment.

SPRAYING SCHEDULE

Maryland Agricultural Experiment Station--Supplement to Bulletin No. 143

APPLES

THE TROUBLE	THE REMEDY	WHEN APPLIED			CULTURAL TREATMENT
		First Application.	Second Application.	Later Applications.	
Scab— Venturia inaequalis.	Bordeaux mixture. (4—5—50)	*Just before the blossoms open.	After petals fall.	Middle of June, and again early in July.	Destroy leaves and fallen fruit in fall.
Leaf Spot— Sphaeropsis malorum and others.	"	Ten days after petals fall.	Three or four weeks later.	Three or four weeks later.	Destroy mummied fruit and dead twigs in fall.
Black Rot— Sphaeropsis malorum.	"	"	"	"	"
Bitter Rot— Glomerella rufomaculans.	"	In bad cases begin early in June and make four or five applications two or three weeks apart.			Destroy cankers on limbs and all rotted fruit.
Fruit Spot— Cylindrosporium pomi.	"	Last of June.	Middle of July.		
Apple Blotch— Phyllosticta solitaria.	"	Four or five weeks after petals fall.	Three or four additional applications three weeks apart.		Destroy cankered wood and diseased fruit.
Fly Speck, Sooty Blotch and minor fungi.	"	Late June.	Late July.		
Apple Rust— Gymnosporangium macropus.		Destroy cedar apples or better, destroy all cedar trees within one-half mile of orchard.			
Fire Blight— Bacilus amylovorus.		Cut out and burn all blighted twigs, paint wounds and disinfect pruning instruments with antiseptic. Keep trees growing slowly but continuously, and use care in pruning.			
Crown Gall— Pseudomonas tumefaciens.	No remedy.	Don't plant infected trees.			
Apple Tree Borer— Injures trunk and roots	Worming.	Remove worms about May 1.			Whitewashing trunk with lime-sulfur serves as a deterrent.
Fruit Tree Bark Beetle— Injures trunk and branches.		Cut out and burn infested parts. Keep orchard clean of all dead wood.			
San Jose Scale— Injures trunk, twigs and fruit.	Lime-sulphur wash or miscible oil.	Before buds open.	In bad cases, again after leaves fall.		

Tussock Caterpillar, Fall web-worm and various leaf eaters.	Arsenical spray.	When worms first attack foliage.	A week later, if needed.		
Codling Moth— Causes wormy fruit.	Arsenical spray.	Just after petals fall.	Ten days later.	Early in July.	Keep trunks scraped and trash cleaned from base of trees.
Tent Caterpillar— Injures leaves.	Arsenical spray.	When eggs hatch.		Cut out twigs bearing eggs. Apply torch to silken tent at night, when discovered.	
Green Aphis— Injures leaves.	Black leaf — kerosene emulsion.	When aphis first appears.	Ten days later, if necessary.		
Woolly Aphis— Injures roots and twigs.	Black leaf — kerosene emulsion—tobacco dust.	When pest appears on twigs.			Apply dust around roots of trees.
Oyster Shell Scale—Scurfy Scale— Injures limbs and branches.	Lime-sulfur — miscible oil—kerosene emulsion.	Same as for San Jose scale. Kerosene emulsion should be applied about May 15.			

* If Lime-sulfur wash is used for scale just before the buds open, this application can be dispensed with.

PEAR

Scab— Venturia pirina.	Bordeaux mixture. (4—5—50)	*Just before the blossoms open.	After petals fall.	Middle of June and last of July.	
Leaf Blight— Entomosporium maculatum.	"	After petals fall.	Three weeks later.	Three weeks later if needed.	
Leaf Spot— Septoria pirina and others.	"	"	"	"	
Fire Blight— Bacillus amylovorus.	Cut out blighted portions several inches below the visible affectation, frequently disinfecting the cut surface and the knives or tools used with corrosive sublimate solution 1-1000. Prune so that fruit-spurs are borne on fruiting branches rather than on main limbs.				
Twig Girdler.	Collect and burn all fallen twigs.				
Pear Tree Psylla— Injures tree by sucking.	Lime-sulfur as a winter spray. Kerosene emulsion in summer when pest appears.				
San Jose Scale— Injures trunk and branches.	Lime-sulfur—Miscible Oil.	Before buds open.			
Pear Slug— Injures leaves.	Arsenical spray—Dusting with lime.	When pest appears.			
Pear Leaf Blister.	Lime-sulfur—Miscible Oil.	While trees are dormant.			Burn injured leaves.

*If Lime-sulfur wash is used for scale just before the buds open, this application can be dispensed with.

QUINCE

Quince troubles are the same as those of Apple and Pear, and receive like treatment.

CHERRY

THE TROUBLE	THE REMEDY	WHEN APPLIED			CULTURAL TREATMENT
		First Application.	Second Application.	Later Applications.	
Leaf Spot— Cylindrosporium padi.	Bordeaux mixture. (3—6—50)	As soon as leaves are out.	Two weeks later.		
Powdery Mildew— Podosphæra oxycanthæ.	"	"	"		
Brown Rot and Twig Blight— Sclerotinia fructigena.	"	As soon as petals fall.	Every two or three weeks as long as there is danger.		
Black Knot— Plowrightia morbosa.	"	When buds begin to swell.	Repeat in two weeks.	Cut out and burn the knots in antumn and as they appear during summer.	
Cherry Aphis— Injures by sucking.	Kerosene emulsion.	When pest appears.			
Slug— Eats foliage.	Arsenical spray — Dust with lime.	When pest appears.			
Cherry Scale— Injures limbs and branches	Lime-sulfur— Miscible oil.	In dormant season.			

PEACH OR APRICOT

THE TROUBLE	THE REMEDY	WHEN APPLIED			CULTURAL TREATMENT
		First Application.	Second Application.	Later Applications.	
Yellows.	No remedy.	Prevent spread by grubbing out trees whenever the peculiar twig growth appears or the fruit prematures.			
Leaf Curl—Exoascus deformans.	Bordeaux-mixture. (4—5—50) or lime-sulfur wash.	Spray before buds open.			
Brown Rot—Sclerotinia fructigena.	Bordeaux mixture. (2—6—50) or self-boiled lime-sulfur (10—10—50.)	Spray before buds open with strong Bordeaux.	After petals fall spray every three weeks as long as there is danger. Watch lest bordeaux injures the leaves.		
Scab or Black Spot—Cladosporium carpophilum.	"	Second week in June.	Two or three weeks later.		
Leaf Spot or Shot-hole—Cercospora persicae and others.	"	"	"		
Peach Tree Borer—Injures crown and roots.	Worming.	About July 1st.	One thorough worming annually is sufficient.		
Black Peach Aphis—Injures leaves and roots.	Black leaf or tobacco dust.	Spray when pest appears. Apply dust around roots.			
San Jose Scale—Injures trunk and branches.	Lime-sulfur—home made or concentrated.	During dormant season.			
Fruit Tree Bark Beetle—Injures trunk and branches.	Same as for apple.				
Peach Lecanium—Injures branches and fruit.	In doubt—miscible oils may prove satisfactory.	Spray in dormant season.			Experiments are in progress as to best remedy.
Plum Curculio—Injures fruit.	Arsenical spray.	Just as leaves appear.	Repeat in 10 days.	Repeat in 10 days if needed.	Jar the insects from tree in early morning. Catch in sheet and destroy.

PLUM

THE TROUBLE	THE REMEDY	WHEN APPLIED			CULTURAL TREATMENT
		First Application.	Second Application.	Later Applications.	
Plum Pockets— Exoascus pruni.	Bordeaux mixture. 4—5—50	*Spray before buds open.			
Leaf Spot or Shot-hole— Cylindrosporium padi.	Bordeaux mixture. 2—6—50	As soon as leaves are out.	Two weeks later.		
Brown Rot— Sclerotinia fructigena.	"	As soon as petals fall.	Every two or three weeks as long as there is danger.		
Black Knot— Plowrightia morbosa.	"	*When buds begin to swell.	Repeat in two weeks.	Cut out and burn the knots in autumn, and as they appear during the summer.	
Canker— (Cause doubtful.)	Cut off and burn cankered branches. Discard affected trees from the nursery.				
Yellows— Cause doubtful.	No remedy.	Prevent spread by grubbing out trees whenever signs of the disease are noticeable.			
San Jose Scale— On trunk and branches.	Same as for Peach.				
Plant Lice— On leaves.	Black leaf.	When pest appears.	Ten days later, if necessary.		
Plum Curculio.	Same as for Peach.				

* If Lime-sulfur wash is used for scale just before the buds open, this application can be dispensed with.

GRAPES

THE TROUBLE	THE REMEDY	First Application.	Second Application.	Later Applications.	CULTURAL TREATMENT
Black Rot— Guignardia bidwellii.	Bordeaux mixture. 6—5—50	*When buds are swelling.	Again in two weeks.	Keep fruit covered with spray until ripe.	Clean up and burn al dead branches.
Anthracnose— Sphaceloma ampelinum	"	"	"	"	Iron sulfate may be used on dormant vines.
Downy Mildew— Plasmopara viticola.	"	When leaves open.	"	Again if needed.	
Powdery Mildew, White rot, Bitter rot, etc.	"	"	"	"	
Broad-necked Prionus— Injures roots.	Worming.	Search for borer when vine shows injury.			
Grape Scale— Injures vines.	Lime-sulfur, Whale oil soap.	During dormant season.			
Miscellaneous Caterpillars Injure leaves.	Arsenical spray.	When pest appears.			
Grape Vine Flea Beetle.	"	In early spring.			
Grape Leaf Folder— Injures leaves.					Destroy folded leaves in the early fall.
Rose Chafer or Rose Bug.	Arsenical spray.	Spray as needed.			Pick bugs in early morning from vines.

* If Lime-sulfur wash is used for scale just before the buds open, this application can be dispensed with.

BLACKBERRY, DEWBERRY OR RASPBERRY

THE TROUBLE	THE REMEDY	WHEN APPLIED			CULTURAL TREATMENT
		First Application.	Second Application.	Later Applications.	
Anthracnose—Gloeosporium venetum	Bordeaux mixture. (4—5—50)	*Before leaves open.	Two or three weeks later.	Two or three weeks later.	Cut out and burn diseased canes.
Rust—Gymnoconia Peckiana.		Dig up and burn diseased plants as soon as the yellow color begins to appear.			
Crown Gall—Pseudomonas tumefaciens.		Dig and burn, and replant on new ground with healthy stock. It is contagious occurring on peach and other trees.			
Blackberry Root Borer—Riddles cane to root.	Cut and destroy infested canes.				Prune carefully.
Rose Scale—Injures cane.	Kerosene emulsion.	When needed.			Prune carefully. Cut out infested canes.

* If Lime-sulfur wash is used for scale just before the buds open, this application can be dispensed with.

CURRANT OR GOOSEBERRY

THE TROUBLE	THE REMEDY	First Application.	Second Application.	Later Applications.	CULTURAL TREATMENT
Leaf Spot—Septoria ribis and Cercospora angulata.	Bordeaux mixture, (4—5—50)	As the leaves are unfolding.	Two weeks later.	Two weeks later.	
Anthracnose—Glœosporium ribis	"	"	"	"	
Mildew—Sphærotheca mors-uvæ.	Bordeaux mixture. (4—5—50) or Potassium Sulfid 1 oz. to 2 gal.	*As buds are swelling.	"	"	
Imported Currant Borer—Tunnels canes.	Cut and destroy infested canes.				
San Jose Scale—Injures twigs.	Same as for apple.				
Imported Currant Worm Injures leaves.	Arsenical spray—Pyrethrum is used.	When pest appears.	10 days later if needed.		

* If Lime-sulfur wash is used for scale just before the buds open, this application can be dispensed with.

STRAWBERRY

THE TROUBLE	THE REMEDY	WHEN APPLIED: First Application.	Second Application.	Later Applications.	CULTURAL TREATMENT
Leaf Spot— Sphærella fragariæ.	Bordeaux mixture. (4—5—50)	After crop has been harvested.	Two weeks later.	Every two weeks as needed.	
Strawberry Root Louse— Injures roots.	Dipping plants in tobacco water before planting.				Burn over bed in early spring.
White Grub— Injures roots.					Rotate crops and apply kainit to plants.
Strawberry weevil— Injures blossom.	Plant resistant varieties or profuse bloomers.				Practice clean culture.

ASPARAGUS

THE TROUBLE	THE REMEDY	First Application.	Second Application.	Later Applications.	CULTURAL TREATMENT
Rust— Puccinia asparagi.	Bordeaux mixture (4—5—50)	Late July.	Every two weeks.		Practice thorough cultivation, late cutting and irrigation.
Asparagus Beetles— Injure plant.	Arsenical spray.	When pest appears.	Ten days later, if necessary.		Brush larvæ off plants on to hot soil.

BEAN

THE TROUBLE	THE REMEDY	First Application.	Second Application.	Later Applications.	CULTURAL TREATMENT
Anthracnose— Colletotrichum lindemuthianum.	Bordeaux mixture (4—5—50)	When plants are two inches high.	Two weeks later.	After they bloom.	Plant perfect seed.
Downy Mildew— Phytophthora phaseoli.	"	About one month after plantiug.	Repeat every two weeks as long as there is danger.		
Rust, Leaf Spot and other fungi.	"	"	"		
Blight— Bacterium phaseoli.	"	Spray frequently as a preventive.			Do not plant on infected soil.
Pea Weevil— Common Bean Weevil— Cowpea Weevil— All injure seed.	Fumigate seed with carbon bisulfid 2½ pounds to 1000 cu. ft. of space.				Tcst seed by placing in water; injured seed will float.
Bean Ladybird— Injures leaves.	Arsenical spray.	When pest appears.	Ten days later, if needed.		

BEET

THE TROUBLE	THE REMEDY	WHEN APPLIED: First Application.	Second Application.	Later Applications.	CULTURAL TREATMENT
Leaf Spot—Cercospora beticola.	Bordeaux mixture (4—5—50)	About one month after planting.	Every two weeks, as needed.		
Cut Worm—Cuts off the plant.	Poison bait.				Thorough fall cultivation.

CABBAGE OR CAULIFLOWER

THE TROUBLE	THE REMEDY	First Application.	Second Application.	Later Applications.	CULTURAL TREATMENT
Downy Mildew—Peronospora parasitica.	Bordeaux mixture. (4—5—50)	If needed, apply while plants are in seed bed.	Every two weeks as needed.		
White Rust, Powdery Mildew, Leaf blight and other fungi.	"	"	"	"	
Black Rot—Pseudomonas campestris.	No remedy.	Possible preventive is to treat seed with corrosive sublimate or formalin. Plant healthy plants and destroy when disease appears. Plant resistant varieties.			
Wilt—Fusarium.	"				Avoid infected land.
Club Root—Plasmodiophora brassicæ.	Use plenty of lime, and avoid infected land.				
Cabbage Maggot—Injures root.	Carbolic acid emulsion—tarred paper cards.				
Imported Cabbage Worm Injures leaves.	Arsenical spray.	When pest appears.	Repeat as needed-		
Striped Flea Beetle and various leaf eaters.	"	"	"		
Cabbage Aphis—Injures leaves.	Black leaf—kerosene emulsion.	"	"		

CARROT, CELERY OR PARSNIP

THE TROUBLE	THE REMEDY	WHEN APPLIED: First Application.	WHEN APPLIED: Second Application.	WHEN APPLIED: Later Applications.	CULTURAL TREATMENT
Leaf Blight—Cercospora or Septoria.	Bordeaux mixture. 4—5—50)	One month after planting.	Every two weeks while new leaves are forming.		
Celery Caterpillar—Injures leaves.	Arsenical spray.	When pest appears.			Pick off and kill caterpillars.
Celery Leaf Tier—Injures leaves.	"	"			"
Carrot Beetle.					Crop rotation and applications of kainit.

CUCUMBER OR MELONS

THE TROUBLE	THE REMEDY	WHEN APPLIED: First Application.	WHEN APPLIED: Second Application.	WHEN APPLIED: Later Applications.	CULTURAL TREATMENT
Downy Mildew—Plasmopara cubensis.	Bordeaux mixture. (4—5—50)	Spray every ten days after July 1st.			
Anthracnose — Colletrotrichum lagenarium.	"	"	"	"	
Leaf Blight—Alternaria brassicæ nigrescens.	"	Spray every two weeks from first bloom until fruit is nearly grown.			
Wilt—Bacillus tracheiphilus.	No remedy.				Burn diseased vines. Keep off insects.
Striped Cucumber Beetle—Injures leaves.	Arsenical spray—Dust with lime or ashes.	As pest appears.	Continue as needed.		To prevent injury to these crops, cover young plants with gauze. Start under glass.
Twelve Spotted Cucumber Beetle—Injures leaves.	"	"	"		Practice clean cultivation and fertilize to stimulate active growth.
Squash Lady bird—Injures leaves.	Arsenical spray.	When pest appears.	Continue as needed.		Hand picking.
Squash Bug—Injures stem and leaves.	Grow trap crops.	Destroy vines after harvesting crop.			
Melon Aphis—Injures leaves.	Black leaf—Kerosene emulsion.	When pest appears.			Destroy vines if badly infested.

LETTUCE

THE TROUBLE	THE REMEDY	WHEN APPLIED: First Application.	Second Application.	Later Applications.	CULTURAL TREATMENT
Rot or Drop— Sclerotinia libertiana.	No remedy.	Destroy diseased plants. Apply top dressing of sterilized soil or sand.			
Downy Mildew— Bremia lactucae.					Plenty of light and ventilation.

PEA

THE TROUBLE	THE REMEDY	First Application.	Second Application.	Later Applications.	CULTURAL TREATMENT
Blight— Ascochyta pisi.	No remedy.	Plant seed free from disease, and do not plant in infected soil.			
Powdery Mildew— Erysiphe communis.	Bordeaux mixture (4—5—50)	When disease first appears.	Later, if needed.		
Insects same as for Bean.					

POTATO

THE TROUBLE	THE REMEDY	First Application.	Second Application.	Later Applications.	CULTURAL TREATMENT
Early Blight— Alternaria solani.	Bordeaux mixture (6—5—50)	Middle of June.	Every two weeks for at least three sprayings.		Not very helpful to early crop.
Late Blight— Phytopthora infestans.	"	"	"	"	Plant sound, healthy potatoes.
Brown Rot— Bacillus solanacearum.	"	"	"		Do not plant on infected land.
Dry Rot— Fusarium oxysporum.	No remedy.				Avoid infected land and plant healthy potatoes.
Scab— Oospora scabies.	Treat seed with formalin or corrosive sublimate.				Avoid infected land and alkaline fertilizer.
Colorado Potato Beetle— Injures leaves.	Arsenical sprays.	When pest appears.	Again, as needed.		
Flea Beetle— Injures leaves.	Arsenicals, with Bordeaux mixture.	"	"		
Black Blister Beetle— Injures leaves.	Arsenical sprays.	"	"		Can be driven into straw patches, where they can be burned.
Potato Stalk Weevil— Injures stalks.	Destroy injured stalks and all vines after digging.				
Cut Worms.	Poisoned bait.				

SWEET POTATO

THE TROUBLE	THE REMEDY	WHEN APPLIED: First Application.	Second Application.	Later Applications.	CULTURAL TREATMENT
Black Rot—Ceratocystis fimbriatia.	No remedy.	Plant healthy seed and keep plants away from affected potatoes.			
Sweet Potato Flea Beetle.	Arsenical spray.	When pest appears.	Again in ten days.		Dip plants in arsenical before planting.
Tortoise Beetle.	"	"	"		"

TOMATO

THE TROUBLE	THE REMEDY	First Application.	Second Application.	Later Applications.	CULTURAL TREATMENT
Leaf Spot or Blight—Septoria lycopersici.	Bordeaux mixture. (4—5—50)	Soon after plants are set out.	Two weeks later.	Every two or three weeks as needed.	Keep plants growing rapidly.
Leaf Mold or Scab—Cladosporium fulvum.	"	"	"	"	
Blight or Wilt—Bacillus solanacearum.	"	Spray thoroughly and frequently. Destroy diseased plants and avoid infected land.			
Cut Worms—Injure plants.	Poisoned bait.				
Tomato Worms—Injure leaves.	Hand picking.				Turkeys may aid in controlling.
Flea Beetles.	Same treatment as under melons.				
Colorado Potato Beetle—Injures young plants.	Arsenical spray.	When pest appears.			

CARNATIONS

THE TROUBLE	THE REMEDY	First Application.	Second Application.	Later Applications.	CULTURAL TREATMENT
Leaf Mold—Heterosporium echinulatum.	Bordeaux mixture. 4—5—50)	Spray every two weeks as needed.			
Leaf Spot and Anthracnose.	"	"	"	"	
Rust—Uromyces caryophyllinus.	"	"	"	"	Destroy diseased plants and use clean stock for propagation.
Bud Rot—Sporotrichum poæ.					Pick and burn diseased buds.

CHRYSANTHEMUM

THE TROUBLE	THE REMEDY	WHEN APPLIED			CULTURAL TREATMENT
		First Application.	Second Application.	Later Applications.	
Leaf Spot—Septoria Chrysanthemi.	Bordeaux mixture. (4–5—50)	Spray as needed.			
Rust—Puccinia Chrysanthemi.		Pick off and burn diseased portions.			
Aphis—Injures leaves.	Black leaf.	When pest appears.	Again as needed.		

ROSES

Powdery Mildew—Sphærotheca pannosa.	Bordeaux mixture. (4—5—50) Dust with sulphur.	As needed.			Use sulfur on the heating pipes.
Leaf Blotch—Actinonema rosea.	Bordeaux mixture. (4—5—50)	As needed, usually in mid-summer.			
Rose Aphis.	Black leaf.	When pest appears.	Again as needed.		
Rose Scale.	Strong soap solution—Kerosene emulsion.	"	"		Cut out badly infested stems.
Rose Slug—Injures leaves.	Arsenical spray—Dust with lime.	When pest appears.	Repeat in mid-summer if second brood appears.		

CHESTNUT

Leaf Spot—Septoria ochroleuca.	Bordeaux mixture. (4—5—50)	Spray as needed.			
Powdery Mildew—Phyllactinia suffulta.	"	"	"		
Green Mold—Penicillium.	No remedy.				
Bark Disease—Diapothe parasitica and others.	"				

CEREALS

THE TROUBLE	THE REMEDY	WHEN APPLIED			CULTURAL TREATMENT
		First Application.	Second Application.	Later Applications.	
Barley Smut—Ustilago nuda.	Formalin or hot water treatment.				
Corn Smut—Ustilago zeæ.	Treatment not usually needed.				
Oat Smut—Ustilago avenæ.	Formalin or hot water treatment.				
Wheat, Loose Smut—Ustilago tritici.	"				
Wheat Stinking Smut—Tilletia fœtens.	"				
Rusts.	No remedy.				Sow resistant varieties.
Corn Aphis.					Practice rotation of crops.
Cut Worms.	Poisoned bait.				Practice fall plowing.
Bud Worm.					"
Angoumois Moth.	Fumigate with carbon bisulfid.				
Weevils.	"				
Hessian Fly.	Plant after frost.				

MISCELLANEOUS

Leaf Spot on Horse-chestnut.	Bordeaux mixture. 4—5—50)	When leaves are half grown.	At three weeks intervals as needed.		
Black Spot of Maple.	"	Spray during summer.			Destroy fallen leaves.
Anthracnose on Poplar.	"	Spray in June and July.			
Anthracnose on Sycamore	"	As leaves appear.			
Bag worm on Arbor vitæ.	Arsenical spray.	When pest appears.			Cut off bags in winter.

INSTRUCTIONS FOR PREPARING REMEDIES.

In the immediately preceding pages there is given a schedule of treatment of the more important horticultural and field crops to prevent or control those fungous and insect troubles that are more frequently found in Maryland. Not all of them can be controlled by spraying and for some, no remedy is known, but in most cases by good cultural methods with proper spraying the damage from the pests will be greatly reduced.

Many other spray mixtures could have been mentioned but to simplify the schedule, only the most prominent remedies have been given. Since complete instructions for making Bordeaux mixture and the self-boiled lime sulfur wash are given in the bulletins of which this schedule is a supplement, only a brief statement will be given here.

BORDEAUX MIXTURE.

Follow the formula given. Dissolve the number of pounds of bluestone indicated by the first figure of the formula in a few gallons of water. Fill the spray barrel two-thirds full of water and add the dissolved bluestone. Slake the number of pounds of lime indicated by the second figure of formula, by slowly adding water until it becomes a thin paste. Wash the lime through a twenty mesh sieve into the solution in the spray barrel, adding water until there is fifty gallons of the whole. Agitate thoroughly and the mixture is ready to apply.

SELF-BOILED LIME-SULFUR.

Mix ten pounds of sulfur with water until a thin paste is formed. To this add ten pounds of good lump lime, adding water as needed for slaking. Keep stirred while slaking. After the mixture has cooled slightly, add water and strain through a twenty mesh sieve forcing all the sulfur through, but keeping out lumps of lime. Add water until there is fifty gallons of the mixture. Keep well agitated while spraying. An arsenical may be added to either of the above for certain insect pests.

FORMALIN.

For potato scab use one-half pint forty per cent. formalin to fifteen gallons for two hours. For grain smut use one pint to fifty gallons.

ARSENICALS.

Poisons of this class are usually applied in the form of a spray or dusted on the plants. They are employed to kill by poisoning insects that do injury by eating the foliage of plants.

PARIS GREEN.

Paris green ....one-third lb.
Lump lime (freshly slaked)............................½ lb.
Water ....50 gal.

In spraying potatoes or other hardy foliage, a larger amount, say one-half pound, may be used, if desired. When adding a dry arsenical to water for spraying, first mix it in a small quantity of water so as to form a paste; then dilute to the proper strength. Paris green is often combined with Bordeaux mixture, a fungicide, in same proportion as above, substituting Bordeaux mixture for the lime and water.

ARSENATE OF LEAD.

Arsenate of lead....................................1½ to 4 lbs.
Water ....50 gal.

This arsenical is used by many in preference to Paris green, for it is the least caustic in its effect upon foliage, remains in suspension and adheres to the foliage for a longer period. There are several brands of the manufactured product on the market.

CONTACT INSECTICIDES.

This class of insecticides may also be applied in the form of a spray or dusted on the plants. They are used to kill insects that do injury by sucking the juices of plants by the caustic effect on their bodies or by smothering them.

SOAP.

The ordinary soft soaps and laundry soaps have long been used for killing insects with soft bodies like plant lice. There are a great many makes of soap, and most all have some insecticidal value. In using, make an emulsion with water, usually about one-half to one pound of soap to one gallon of water.

KEROSENE EMULSION.

This, no doubt, is the best general purpose contact insecticide. It is easy to prepare, and the materials composing it are always at hand. The emulsion can be made using the ingredients in the following proportions:

Kerosene ....2 gal.
Common soap ....½ pound.
Water ....1 gal.

Dissolve the soap in hot water, add the kerosene, and emulsify by violent churning. Dilute to the strength required. If Ta-Ka-Nap soap is used, it is not necessary to use hot water. Twelve to fifteen per cent. of kerosene is strong enough for killing plant lice.

HOME-MADE LIME-SULFUR WASH.

This wash seems to be the most satisfactory solution for the control of the San Jose scale. It should be applied either in the fall or early spring, while the trees are dormant.

Fresh stone lime.....................................20 pounds.
Flowers or flour of sulfur..........................15 pounds.
Water ....50 gallons.

Boil twenty gallons of water in an iron pot or hog scalder; now add the twenty pounds of lime and fifteen pounds of sulfur, which should have been previously mixed with a little hot water to form a paste. Boil the mixture, stirring occasionally, from thirty minutes to one hour, or until the sulfur is thoroughly dissolved, and produces a clear, amber-colored solution. Then dilute by adding sufficient hot or cold water to make fifty gallons. Strain into the spray barrel and apply warm.

CONCENTRATED LIME-SULFUR SOLUTIONS.

There are several brands of the concentrated lime-sulfur solutions on the market that may be employed instead of making the above home-made wash. They may be used at the rate of one part of the solution to nine parts of water, applied to dormant trees.

TOBACCO—BLACK LEAF.

Tobacco dust may be used quite heavily around trees as it contains some fertilizing qualities. In planting young trees, a couple handfuls to a tree is sufficient. Tobacco stems are sometimes steeped in hot water, one pound to a gallon or two of water and used as a spray against plant lice.

Black-leaf, a tobacco extract diluted to one part of the extract to forty or fifty parts of water is an excellent spray for plant lice.

HYDROCYANIC ACID GAS.

This gas has come into use of late years as an important insecticide, and is made as follows:

Cyanide of potassium, 98%	1 ounce.
Sulphuric acid (commercial)	2 ounces.
Water	4 ounces.

This formula will fumigate an enclosure containing one hundred cubic feet; the proper proportion for larger or smaller space can be calculated from this. Place acid in an earthen jar, then add water and cyanide. Be sure to have the room or enclosure air-tight, or nearly so. Keep everything closed for at least thirty minutes or longer. It is a very *deadly gas,* and much care should be exercised in its use.

BI-SULPHIDE OF CARBON.

This liquid is used in destroying insects in stored-grain, and the like. The liquid evaporates very rapidly. In fumigating grain, or other similar material, use two or three pounds of the liquid to one hundred bushels of grain. Place the liquid in small pans above the material to be fumigated. Have the enclosure air-tight or nearly so, and fumigate from twelve to twenty-four hours. The gas is exceedingly explosive, therefore, do not allow any *light,* cigar, or pipe, in the building when fumigating. This gas is heavier than the air.

For further information concerning these or other methods of disease and insect control write to the Experiment Station, sending samples if possible.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 144 MARCH, 1910

APPLE CULTURE.

By C. P. Close.

INTRODUCTION.

There is a rapidly growing interest in apple culture over nearly all sections of the United States where apples can be grown, but in no section is there a healthier interest than is springing up in Maryland. Not only are our own citizens waking up to the fact that apple growing is one of the most satisfactory and profitable of out-door employments, but people from many other states are realizing the same thing and are writing for information on climate, soil, and best location in Maryland for apple culture. While this industry will not jump into existence over large areas almost instantly like it does in the Far West, it will take on a permanent and improved form together with a rapid growth and development. The insect and disease situation is well enough understood now so that there is no cause for the repetition of the terrible alarm which followed the spread of the San Jose scale a few years ago.

The man who intends to raise apples must understand at the outset that he has a continual fight on his hands and must get down to good, hard, honest and intelligent work to make a real success of the venture. This statement, however, need not frighten the man with pluck, but should prevent the over cautious and timid one from embarking into something which would probably not be carried to a successful completion.

Although none of the startling records of enormous profits have been made in the East as in the West, yet the writer firmly believes that with the same money investment, the same intelligence, the same work, the same modern methods of growing, packing and selling, and the same hustle and organization used in the West, Maryland can equal in profits any section in the Great West in producing and marketing apples. The western apples do take on a higher finish, but it is only skin deep, and beneath the skin where flavor and quality are stored, the Maryland apples excel their western rivals.

NATURAL CONDITIONS.

The natural conditions of Maryland for apple production could hardly be improved. On the Eastern Shore the climate is tempered by

the adjacent large bodies of water, and the summer varieties ripen in June and early in July while prices are high. The many streams afford shipping outlets by water, and the soil is especially adapted to apple culture, particularly the sandy loams. The same is true of Southern Maryland. The northern portions of the State have rather heavier soils rolling in contour in the north and mountainous in the west, but nearly all well adapted to varieties of all seasons, and particularly to the fall and winter sorts because the summer kinds ripen too late to bring the highest prices.

SOILS.

The writer prefers above all others a rich, sandy loam with clay subsoil for this makes a most favorable home for the tree roots and can be worked early in spring and soon after a heavy rain without fear of puddling and baking. It also responds readily to the use of fertilizers and cover crops and produces fruit of highest color and early in ripening. The gravel soils are excellent also.

The clay loams and even heavy clay will produce fine apples if properly handled and thoroughly drained. To loosen up the heavy soils, plenty of manure and cover crops must be used, and they must not be worked when too wet or they will puddle, nor on the other hand be plowed when too dry or they become lumpy. When in just the right condition of moisture they work up nicely, this condition is easily learned by experience.

The stony soils of the mountains of Western Maryland are producing the finest kind of fruit and there is no question of their adaptability to apple culture.

Almost all of the well drained soils of the State will produce good apples so far as the soil itself is concerned, but local conditions may make certain areas unfavorable for orchard purposes.

IMPROVING SOILS.

It is, of course, best to use soils which are fertile and in good tilth when the trees are planted, but thin and infertile soils may be used if necessary in order to save time if the trees are well fertilized while the ground is being improved. The first thing to do is to get vegetable matter into the soil, and without large quantities of stable manure this is best done with the clovers, cowpeas, soy beans, etc., the nitrogen gathering or leguminous crops. Beginning in August the ground should be well prepared and fifteen to twenty pounds of crimson clover seed per acre be sown if the soil is not too impoverished to grow clover, but in case it is, then one bushel of rye per acre should be sown instead. The resulting crop should be plowed under about May 1, and one bushel of cowpeas per acre sown at once. This crop should be plowed under early in August and crimson clover seeded immediately.

If this plan can be followed for two or three years the ground will be wonderfully benefitted, and if some commercial fertilizer can be ap-

plied twice a year when the seeding is done, the benefit will be much increased. The following amounts per acre broadcasted will be decidedly beneficial: 75 to 100 pounds of muriate or sulphate of potash, 200 to 250 pounds of acid phosphate or dissolved bone, and 50 pounds of nitrate of soda or sulphate of ammonia.

If stable manure is available it may be used as generously as the supply will warrant.

In case the trees are planted when fertility improvement begins, about two pounds of the above mixture of fertilizers should be worked into the soil around each tree each spring.

EXPOSURE AND AIR DRAINAGE.

Of these two important items in apple culture, the latter is probably more exacting in its requirements than the former.

Except in the mountainous district of Western Maryland and the rolling sections near the Pennsylvania line, there is not much choice regarding exposure and the air drainage is not always as good as desired. This applies to the flat lands not very much elevated above sea level. On these lands the deficiency in air drainage must be offset by the practice of orchard heating as is done in the West.

On the rough rolling lands, the exposure does not perhaps matter much except that abrupt broad slopes straight north or south are not so desirable as others. The north-western, western and south-western exposures are no doubt somewhat preferable to the north-eastern, eastern and south-eastern in case the slopes are steep and long, but the difference in choice would be slight on gentle slopes. The two points which must be considered are, the outlet for air drainage and the absence of coves of cold air. A free outlet allowing the cold air to be carried away from the lowest points of the orchard is necessary. Cold air being heavier than mild or warm air, settles and slides down grade much like water does. If there is no outlet the coldest air sinks to the lowest places and results in late spring frosts and early fall frosts. Hollows or coves on the slopes should be avoided for this very reason. The slope must let the cold air roll off.

It may seem strange that fruit trees on a cold ridge in the mountain district will often fruit better and more regularly than trees in the warmer valleys. The reason is that the air on the ridge is more uniformly cold and remains so until late in the spring and the fruit buds are late in opening thus escaping late frosts.

In the valleys the temperature is changeable from mild or warm to cold. A few mild days in early spring often cause the fruit buds to swell or even to open and when in this tender condition a late frost easily ruins them.

WATER DRAINAGE.

The question of soil or water drainage can only be considered in a general way. Apple trees cannot stand wet feet and the ground must be well drained or used for other purposes. Surface drains will usually

take care of the surplus water, but tile drains will do it better in many instances. Tile draining is expensive, but is recommended if it can be afforded.

On steep slopes the washing of the soil by surface water can usually be prevented by furrows or unplowed strips following the contour of the ground. These arrest the rapid downward flow and cause much of the water to soak into the ground. This will be mentioned under cultivation.

PREPARATION OF LAND.

After a choice of location for the orchard has been made, the ground should be plowed as deep as practicable, using a subsoil plow if possible, and worked into fine condition. The subsoil ought to be broken up a foot and one-half or two feet deep, but this is seldom done. Sometimes for special reasons, only the tree row strips are plowed leaving the middles to be worked up later.

ORDERING TREES.

After the fruit grower decides definitely what varieties he will plant, he should write to the nearest reliable nurserymen asking if they can furnish the varieties desired and at what price. He should state the number of trees of each variety wanted, the age, and size or grade, and specify definitely that under no condition will disease or insect infested trees be accepted, nor will the substitution of varieties or grades be countenanced unless by mutually agreement. A definite bargain should be made so that both sides know exactly what has been agreed upon. It is well to save the bill of sale and the correspondence for future reference, for the Court of Appeals* in New York State has decided recently that nurserymen may be sued for damages resulting from the substitution of varieties.

It would be well for fruit growers to deal direct with nurserymen rather than to depend on tree agents unless the agent is known to directly represent a reliable firm. Nurserymen are more responsible than agents. While there are some reliable tree agents, there are also many unreliable ones scouring the country with gaudy lithographs of imaginary fruits and selling all kinds of varietiees at high prices for any and all sections. It has been a customary practice for unreliable tree agents to fill orders of many varieties from a pile of trees of a single variety. This is a simple matter, a tree label does it.

AGE AND KIND OF NURSERY TREE FOR PLANTING.

The writer prefers above all others a well grown one-year old budded tree. A one-year old tree may be headed low and the first crop of branches may be used for the foundation branches, selecting those

*Rural New Yorker, December 25, 1909, pages 1102 and 1110 and January 15, 1910, page 56.

best placed. Nurserymen usually cut these off in growing higher headed trees. Unless a two-year old tree has been headed low in the nursery it is usually necessary to force the development of new foundation branches low on the trunk and these are not always well placed. Furthermore, a one-year old tree is cheaper than a two-year old tree.

Budded trees are preferable to root grafted ones because root grafting induces the development of crown gall. The necessary cuts made in root grafting prove easy points of infection for the spores of this disease. If nurserymen would bind cloth around the union in root grafting, there would be less damage from this source. If the roots of budded trees are injured by cultivation, or otherwise, the spores of crown gall are likely to enter and cause the disease. Trees affected with crown gall or hairy root should never be planted, they should be destroyed at once.

SPRING OR FALL PLANTING.

Except in the very coldest parts of the State, fall planting is undoubtedly best for several reasons. If the planting is done then it is out of the rush of spring work; the weather is usually pleasant in November or early December; the trees get an earlier start into growth in the spring; and the danger of other work or bad weather delaying spring planting is overcome.

If spring planting can be done early it is entirely satisfactory and late planting is better than no planting at all. The point is to do the planting in the fall or early in the spring.

DISTANCE APART TO PLANT THE TREES.

Most of the Maryland soils will grow good large trees, and forty feet apart each way is about the right distance for planting, thus requiring twenty-eight trees to the acre. These are the permanent trees and since it will be many years before they will require all of the ground a temporary tree, or filler, should be set between each two permanent trees in every row and a filler row between each two permanent rows. This arrangement makes the rows twenty feet apart each way and requires 108 trees per acre, (see fig. 1).

LAYING OUT THE ORCHARD.

Any one of several methods is satisfactory for laying out the orchard. The simplest is to set tall stakes twenty feet apart along both sides and across the middle of the field and plow straight furrows between the stakes. Cross furrows are made in the same way. A little digging out is needed where the furrows intersect and the trees may be planted. By sighting along the row, if aided by one or two stakes, the trees may be lined up fairly well.

Another method is to set stakes twenty feet apart across the sides of the field and stretch a wire with markers twenty feet apart between

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Fig 1.—Laying out an orchard. Permanent trees are represented by x. Filler trees are represented by o.

opposite stakes. A small stake is driven down at each marker to locate the position of each tree. Holes are dug and trees are lined up by sighting along and across the row, but this method requires a man or two extra to do the sighting.

A planting board made by cutting a deep notch in the middle and one near the end equally distant from the centre, is convenient. A board

Fig. 2.—The planting board in use. (After Waugh in The American Apple Orchard).

three or four inches wide will answer the purpose. The centre notch is placed against a stake marking the location of a tree. Then another stake is driven in each end notch and the centre stake and board are removed. The hole is dug and the planting board is replaced against the end stakes. The tree is set in the centre notch and the earth is filled in to hold it in place. (See fig. 2).

PRUNING TREES FOR PLANTING.

Some fruit growers prefer to have trees with long roots and others prune off all side roots leaving only the main stub root. (This latter is the Stringfellow method of stub pruning). A long root is useless and undesirable and the stub root cannot be generally advocated. A happy medium of three or four inches is strongly recommended for general use. Prune off all injured roots and cut the others back to

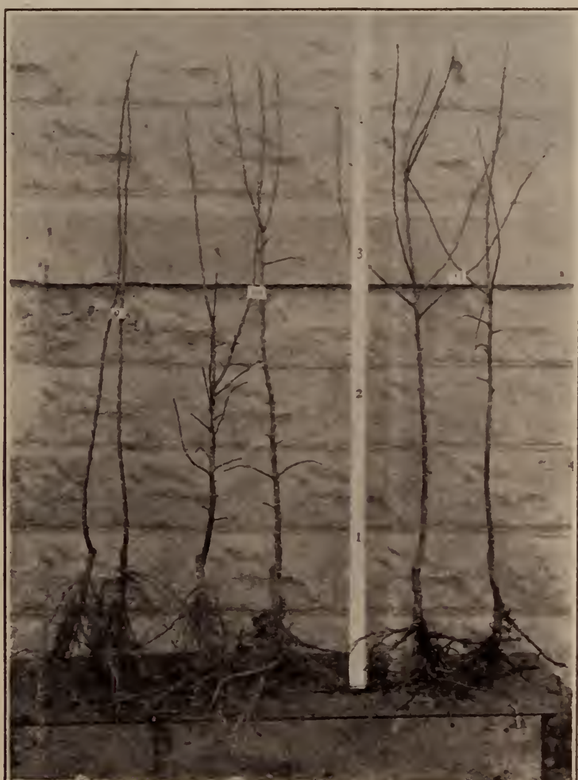


Fig. 3.—No. 9 shows two 1-year old budded trees.
No. 10—shows two 2-year old low branched budded trees.
No. 11 shows two 2-year old higher branched budded trees.
All are Stayman Winesap trees just as they came from the nursery. (Photo. by Ballard).

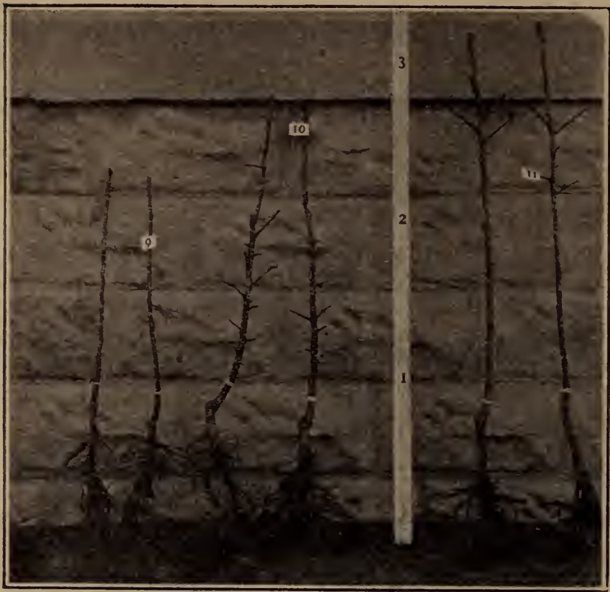


Fig. 4.—The same trees shown in fig. 3 but trimmed for planting. No. 9 are headed at 18 inches, No. 10 at 2 feet and No. 11 at 2½ feet. The white string above the roots shows how deep the trees should be planted in the orchard. (Photo. by Ballard).

three or four inches in length. The end of every root should be a smooth cut. Throw out all diseased trees.

The top may be pruned before the tree is planted or immediately after, the latter being preferable. Select from three to five branches distributed around the trunk at different heights to form the foundation branches. Cut these back to from four to six inches in length. Cut the other branches above the second or third bud rather than short up to the trunk. This promotes the development of more leaf surface which induces increased growth instead of leaving trunk wounds for the weakened tree to heal over as is done in close pruning. If the tree is to be low headed the top should be cut off one and one-half or two feet above the ground, if high headed at about four feet from the ground. Low heading is especially recommended. Figures 3 and 4 show one and two year old trees before and after being pruned for planting.

ADVANTAGES OF LOW HEADING.

Fortunately, the old style of high headed apple trees is going out of favor with progressive fruit growers, and the common sense method of low heading is taking its place. There are really no disadvantages with low headed trees if they are properly pruned each year as mentioned under "Pruning Young Orchard Trees." The limbs will be short and

stout and ascend obliquely so as to be out of the way of orchard implements, especially the extension implements.

The low headed trees have the advantage of high headed ones in being easier and cheaper to spray, prune, and gather fruit from, and in less injury to dropped fruit and less injury by storms. The fruit will color and ripen as well on low trees as on high ones. Fruit growers should demand low headed trees from nurserymen.

PLANTING THE TREES.

In mellow and well prepared soil the hole need be only wide and deep enough to receive the tree easily. In hard ground or sod it should be three feet or more across and deep enough to set the tree two or more inches lower than it stood in the nursery (see fig. 4). Hold the tree in position, shovel in the mellow top soil, "joggle" the tree up and down slightly to settle the earth around the roots, tramp or pack the earth firmly around and over the roots, fill up the hole, pack well and throw a little loose earth on as a mulch to retain moisture. In carrying the trees from hole to hole they should be wrapped in wet burlap or other material to prevent the roots from drying out.

HEELING IN TREES.

If trees cannot be planted as soon as they are received from the nursery they should be heeled in at once. This consists in digging a trench in which to stand or recline the trees and shoveling earth over the roots and part of the trunks. This shoveling opens up a new parallel trench into which more trees may be placed and covered.

If trees are heeled in during the fall it is well to point the tops toward the south so the limbs will shade the trunks and prevent injury by alternate thawing and freezing in mild winter weather.

PRUNING YOUNG ORCHARD TREES.

1st year—This consists of the pruning done when the trees are planted, but if any new shoots tend to make the trees unsymmetrical the tips should be pinched off in summer to check their growth. This summer pinching of unsymmetrical shoots should be done whenever necessary in following years.

2d year—Cut out all surplus branches and prune back the foundation branches from one-third to one-half of their growth making the tree symmetrical and leaving the central leading shoot longer than the others. Avoid the formation of crotches as they are sure to split down and ruin the trees.

3d year—Prune as much as mentioned for second year. If twigs have grown on the foundation branches near the trunk do not disturb them except to cut them back to one or two buds to induce the development of fruit spurs; this may need to be done several times during the summer also. Do not let two branches cross or rub, remove one.

4th and following years—Until the trees begin to bear, the foundation branches should be cut back annually to make them short and strong to support heavy loads of fruit without breaking down. After fruiting begins not much pruning is necessary except to thin out surplus growth and keep the tree symmetrical. Prune from the top down and not from the bottom up.

In cutting or sawing a limb from the trunk or a small limb from a larger one, the cut should be made close up to the trunk or larger limb so as not to leave a stub. Wounds made by proper pruning heal over readily, but stubs are seldom healed over and they decay and lead the decay into the trunk thus weakening and injuring it.

Wounds over three-quarters of an inch across should be covered with white lead and pure linseed oil paint to prevent the exposed wood from drying out. Wounds may in May or June will heal over more quickly than those made at any other time of the year.

THE CULTIVATING AND CROPPING OF YOUNG ORCHARDS.

The writer is decidedly in favor of cultivation for the apple orchards of Maryland. The practice will need to be modified in different parts of the State for a mountain orchard cannot be handled like an orchard on level land.

If the orchard is not to be cropped its management is very simple on level or somewhat rolling land. It should be plowed in spring as soon as the ground is in good plowing condition and be thoroughly harrowed to work the soil into good tilth. Every ten days or two weeks the harrow should be run over the ground to loosen it up unless a heavy rain has packed it down in the meantime when it should be harrowed as soon as dry enough. The point is to keep a fine and loose dust mulch to prevent the evaporation of soil moisture.

This harrowing should be continued until about the first of August when as soon as weather conditions are favorable the cover crop seed should be sown. The commercial fertilizer should be applied and worked into the soil just before the cover crop seed is sown. In this way the cover crop gets the immediate effect of the fertilizer and when this crop is plowed under the following spring it soon decays and makes available plant food for the trees. The cultivation for following years is about the same as mentioned for the first year.

In hilly or mountainous orchards this complete cultivation can not safely be adopted on account of the danger of serious washing away of the soil unless furrows are plowed following the contour of the land to check the washing. It may be necessary to plow strips eight or ten feet wide along the rows in spring and cultivate these until August when the middles may be plowed and the fertilizer applied and cover crop seed sown. A cover crop used successfully in Western Maryland is a mixture of crimson and red clover. The crimson clover grows rapidly in spring and after it blooms and dies down on the unplowed middles the red clover takes its place thus making a live cover until the

ground is plowed in preparation for the fall fertilizer and cover crop seed.

It is a good practice to grow some early maturing hoed crop among the young trees until they begin to bear, but extra fertilizer or manure must be used for this crop so the trees will not be injured. Such crops as early potatoes, tomatoes, melons, sweet corn, and anything which is not late in maturing, are best, because late cultivation for late maturing crops may cause late growth on the trees and if this growth fails to ripen it may be winter killed.

After the trees are in good bearing the orchard ought not to be planted to any other crop yet this is done successfully if intelligently practiced and plenty of fertilizer or manure is used. Most varieties will bear some fruit five or six years from planting and usually a profitable crop is produced two or three years later. The age of bearing varies with varieties and location.

The small grains like wheat, rye and oats should never be allowed to mature in the orchard because they require so much moisture of which they rob the trees.

CARE OF OLD AND NEGLECTED ORCHARDS.

If the trees crowd each other, enough of them must be taken out to afford relief and let in sunlight and give free circulation of air. Long projecting branches should be cut back and all dead, badly diseased, weak, and surplus limbs be removed. The cuts should be made close up to the trunk or supporting limb so as not to leave a stub, and all wounds should be painted with white lead and linseed oil.

In taking off large limbs saw upward from the lower side about one-fourth through, then saw from the top to meet the lower cut and the limbs will drop off without splitting or tearing down the bark and sap-wood.

If there are diseased and hollow places in the trunk and limbs, scrape out all decay and treat the healthy interior with thick Bordeaux mixture, or copper sulphate one ounce to one gallon of water, and fill up with concrete. The old trunks will be improved by having the rough bark scraped off.

Give the orchard a liberal dressing of manure or commercial fertilizer in early spring and plow the ground about four inches deep. Work the soil into fine condition and harrow often enough during the summer to make a good earth mulch and early in August sow the cover crop seed.

Proper spraying is absolutely necessary and depends upon the kind and amount of diseases and insects present, see pages 264 and 265.

SOD CULTURE FOR ORCHARDS.

In a few favored localities orchards do well in sod. There must be plenty of moisture so neither trees nor grass will suffer. Usually sheep or hogs are pastured in these orchards and add considerable fer-

tility to the soil. Hogs root up the ground more or less thus cultivating it in patches, but this is expensive cultivation. If the grass becomes large enough it is cut and allowed to lie where it falls. Sod culture is not recommended for Maryland.

MULCH CULTURE FOR ORCHARDS.

Mulch culture must not be confused with sod culture from which it differs in that not only the grass growing on the ground is cut and left to decay, but straw, rubbish, manure and other materials are added to form a heavy mulch. This is much better than sod culture but not so good as cultivation and is not recommended.

COVER CROPS.

A cover crop is a covering of plants on the ground when the tree growth is not very active, or entirely dormant. The principal uses of a cover crop are as follows: to check the growth of trees in the fall and cause them to ripen their wood; to take up soluble plant food which might otherwise leach out into the drainage in late fall and early spring; to catch the rain and conduct it into the soil rather than to let it run over the surface and wash away the loose solid, and to hold the snow to further protect the soil; to protect the ground from deep freezing; to catch soluble plant food in early spring before root action begins in the trees; to pump the surplus water out of the ground in the early spring and thus help to warm it up; and to add vegetable matter to the soil. The cover crop must be plowed under in the spring before it dries out the soil enough to affect the trees.

The humus or vegetable matter in the cover crop helps to improve the mechanical condition of the ground by loosening up the soil particles; to increase the water holding power of the soil; to provide a favorable home for soil bacteria; to furnish elements of plant food in available form; and to assist in breaking up chemical compounds of plant food which might otherwise remain unavailable. Cover crop plants may be divided into three classes; the leguminous ones or nitrogen gatherers like the clovers, vetches, alfalfa, cowpea, soy bean, Canada pea and velvet bean; the potash plants like cow horn turnips and rape, and ordinary plants like rye, oats, buckwheat and weeds.

The nitrogen gatherers are so named because special forms of soil bacteria associate with them and extract free nitrogen from the air and store it in tubercles on the plant roots. If a soil is deficient in nitrogen these bacteria form many tubercles on the roots of the plants, but if the soil is well supplied with humus and nitrogen they form fewer tubercles on the roots. This class of plants also returns large amounts of potash and phosphoric acid to the soil.

The potash plants seem to be gross feeders and take up cruder forms of plant food than the more delicate nitrogen gatherers, but store up much nitrogen as well as potash and considerable phosphoric acid.

The other class of plants is useful when enough nitrogen is stored in the ground and a winter cover only is needed. The small grains should never be allowed to ripen in an orchard.

Cover crop seed should be sown early in August if weather conditions are favorable. The fertilizer should be applied when the ground is prepared for the cover crop seed. Small seeds like clover should be covered with a very light smoothing harrow or weeder and large seeds with a heavy harrow.

Unless there is moisture enough in the soil to germinate the seeds, seeding should be delayed until rain comes. Crimson clover especially will not germinate in a dry soil. Seeding in dry soil will probably result in failure.

The following table showing the amounts of nitrogen, phosphoric acid and potash per acre in different cover crops four months from seeding, is taken from page 29 of the Delaware Experiment Station Bulletin No. 61, prepared by the writer in 1903. The amounts of fertilizers which the nitrogen, phosphoric acid and potash are equivalent to are also given.

	Cowhorn Turnips	Rape	Crimson Clover	Red Clover	Alfalfa	Hairy Vetch	Cowpeas	Soy Beans
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pouuds	Pounds
Nitrogen	109.5	129.4	134.4	103.0	95.2	121.2	69.5	140.2
Equivalent to Nitrate of soda (16%)	684.2	808.8	840.0	643.8	595.0	757.5	433.4	876.2
Phosphoric Acid	26.0	46.9	61.2	29.0	21.6	27.2	18.9	40.2
Equal to Acid Phosphate (14%)	185.7	335.0	437.1	207.1	154.3	194.3	135.0	287.1
Potash	142.6	161.3	88.2	56.4	41.7	85.5	49.8	48.0
Equal to Muriate of Potash (50%)	285.2	322.6	176.4	112.8	83.4	171.0	99.6	96.0

This table shows the enormous amounts of nitrogen in the different cover crops ranging from the equivalent of 433 pounds of nitrate of soda (16%) in cowpeas to 876 pounds in soy beans. Crimson clover contains the equivalent of 840 pounds and rape 808 pounds of nitrate of soda. All of the crops are high in nitrogen.

Phosphoric acid is also abundant varying from the equivalent of 135 pounds of acid phosphate (14%) in cowpeas to 437 pounds in crimson clover.

Potash is not quite so plentiful, but runs from the equivalent of 83 pounds of muriate of potash (50%) in alfalfa to 322 pounds in rape.

The plant food in one acre of this crimson clover equals the following mixture:

840 pounds nitrate of soda.
437 pounds acid phosphate.
176 pounds muriate of potash.

The crop of rape equals:

808 pounds nitrate of soda.
335 pounds acid phosphate.
322 pounds muriate of potash.

All of the other crops are also high in plant food.

AMOUNT OF SEED PER ACRE.

The different clovers should be sown at the rate of 12 to 20 pounds of seed per acre; hairy vetch 40 pounds per acre; cowpeas and soy beans 1 to 1½ bushels per acre; cow horn turnips 1 to 2 pounds per acre; dwarf Essex rape 8 to 10 pounds per acre. Combinations of various kinds may be made using one-half the amounts of seed just mentioned when two kinds are used together, one-third of each kind when three are used, etc. Crimson clover 10 pounds and cowhorn turnips 1 pound, make one of the very best combinations.

Crimson clover is the best cover crop because it lives over winter and adds so much available plant food and humus to the soil. Cowpeas and soy beans are killed by the first hard frost. Hairy vetch and red clover are hardy. Rape and cowhorn turnips die down during the winter, but many of the roots send up seed stalks in spring.

If it is desired to have a summer cover crop, the best practice is to sow cowpeas in rows and cultivate them occasionally. The tops may be cut for hay and the stubble plowed under in August.

FERTILIZERS AND MANURES.

It is impossible to say what is the best fertilizer to use because it all depends on the age and condition of the orchard, the kind of soil and the treatment it has had for several years. Some soils are rich in potash and deficient in phosphoric acid and others are just the reverse. Stable manure in large amounts is always acceptable unless the trees are making a rank growth. Cover crops add much plant food and vegetable matter to the soil and are necessary. Commercial fertilizers are depended upon to supply what is still needed.

If it is a correct supposition that the amount of plant food necessary for bearing trees can be determined from chemical analyses of the fruit, leaves and twigs computed on the total amount of fruit, leaves and wood growth made per year, then many fruit growers have been using unbalanced fertilizers with too much phosphoric acid. The writer has endeavored to get at this question from the standpoint of the amount of plant food in the fruit and leaves on trees producing five bushels of fruit each, and the indications are that the amounts of nitrogen, phos-

phoric acid and potash required for 108 trees per acre are equivalent to the plant food in 440 pounds of nitrate of soda, 100 pounds of acid phosphate, and 160 pounds of muriate of potash per year. Four hundred and forty pounds of nitrate of soda, or its equivalent per acre, is such an excessive amount to apply, and since a cover crop will furnish much of this, about 200 pounds per acre will be considered standard here as explained below. In other words then, trees producing five bushels of apples will need about the equivalent of two pounds of nitrate of soda, one pound of acid phosphate and one and one-half pounds of muriate of potash per tree annually. Trees yielding from seven to eight bushels of fruit will need one-half more than the above amounts and those yielding ten or fifteen bushels each will need two or three times as much. Trees with larger yields will need proportionately more fertilizers. This is based on the analysis of fruit and leaves reported in table V, page 535, Cornell bulletin, No. 103. No accurate estimate can be made of the plant food necessary to make and mature the wood growth of top and roots each year although on page 538 of the same bulletin two tables indicate that for an old and not well cared for apple tree, the amount of nitrogen and phosphoric acid in leaves and one year's growth of twigs is about equal, and the potash is one-half as much in the limbs as in the leaves. If it is desired to apply plant food to supply that probably needed for twig growth the following amounts or their equivalents per tree should be added to that mentioned above: one pound of nitrate of soda, one-half pound of acid phosphate and one-half pound of muriate of potash.

Cover crops add large amounts of plant food to the soil and thus help to reduce the expense of fertilizers. In some cover crop work conducted by the writer in 1902-3 and reported on page 29 in bulletin No. 61, of the Delaware Experiment Station, crimson clover four months old produced per acre 134.4 pounds of nitrogen equal to 837 pounds of nitrate of soda, 61.2 pounds of phosphoric acid equal to 510 pounds of acid phosphate, and 88.2 pounds of potash equal to 176.4 pounds of muriate of potash. Not all cover crops will do as well as this one, but on the strength of doing something the total of 440 pounds of nitrate of soda mentioned above was reduced to about 200 pounds.

If a regular system of fertilizing and cover cropping is followed, the fertilizer ought to be applied when the ground is fitted for the cover crop seed early in August. In other practices it should be applied early in spring.

From the above discussion the following amounts of fertilizers are suggested for practical use with the understanding that the fruit grower must vary them according to the needs of his land, using larger amounts of those in which his land seems to be deficient.

Fertilizer per year for tree producing five bushels of apples.

Formula I	2 to 3	pounds nitrate of soda (16%) or its equivalent.
	1 to 1½	pounds acid phosphate (14%) or its equivalent.
	1½ to 2	pounds of muriate of potash (50%) or its equivalent.

Fertilizer per year for tree producing ten bushels of apples.

Formula II	2 to 3	pounds nitrate of soda (16%) or its equivalent.
	2 to 3	pounds acid phosphate (14%) or its equivalent.
	3 to 4	pounds muriate of potash (50%) or its equivalent.

Fertilizer per acre per year, trees 20 feet apart (108 per acre) producing 5 bushels of fruit per tree. Fewer trees per acre need correspondingly less fertilizer.

Formula III	216 to 324	pounds nitrate of soda (16%) or its equivalent.
	108 to 162	pounds acid phosphate (14%) or its equivalent.
	162 to 216	pounds muriate of potash (50%) or its equivalent.

Fertilizer per acre per year, trees 20 feet apart (108 per acre) producing 10 bushels or more of fruit per tree. Fewer trees per acre need correspondingly less fertilizer.

Formula IV	216 to 324	pounds nitrate of soda (16%) or its equivalent.
	216 to 324	pounds acid phosphate (14%) or its equivalent.
	324 to 432	pounds muriate of potash (50%) or its equivalent.

Ton lots of fertilizer in the proportion given in formulas I, II, III and IV. Use 486 pounds per acre of (108 trees on trees producing 5 bushels of fruit each and proportionately more or less for trees bearing more or less fruit.

Formula V	888	pounds nitrate of soda (16%) or its equivalent.
	444	pounds acid phosphate (14%) or its equivalent.
	668	pounds muriate of potash (50%) or its equivalent.
	2000	

The per cent of plant food in all of these formulas (except II and IV) is the same, namely 7 per cent nitrogen, 3 phosphoric acid and 17 per cent potash.

It will be noticed that the amount of nitrate of soda or its equivalent is not doubled in formulas II and IV. The reason for this is the high expense of nitrogen and the desire to have cover crops grown to supply nitrogen.

For young trees bearing less than five bushels of fruit each, the amount of fertilizer required is about one-fifth of that mentioned in formula I for each bushel of apples borne. Younger trees should receive from one-half pound to one pound each of the mixture given in formula I.

The kinds of fertilizers mentioned in the formulas are given to illustrate what is required, but need not be used if the fruit grower prefers other sources of plant food. In fact, it would be better to supply part of the nitrogen in tankage, ground fish, or something else, rather than to use nitrate of soda alone. The same is true with respect to phosphoric acid and potash.

The amounts of nitrogen, phosphoric acid and potash in different cover crops are mentioned under "cover crops" on page 229.

PRUNING.

Pruning may be done at any time during the year, but some seasons are better than others for this purpose. The bulk of pruning is done during the winter and spring because there is time to do it then and the results are usually good. Pruning wounds will heal quickest if made in May or June.

Careful summer pruning is of immense importance because the new growth can be so easily guided and controlled. Young trees ought to be examined every three or four weeks in the growing season when much of the pruning can be done by pinching out new growth with the thumb and finger where necessary.

It sometimes happens that young trees grow so vigorously they do not begin to bear fruit for several years after they should be producing profitable crops. This tendency toward wood production can often be checked and fruit production induced by rather severe pruning early in June.

One of the most common mistakes is to prune from the bottom up instead of from the top down. Leaves and fruit spurs should be encouraged to form on the main limbs of young trees and be left there. Many of the twigs which form on these limbs may be changed into fruit spurs by cutting them back to one or two inches in length several times a year. Old trees cannot be brought back to this condition, but the main limbs ought not to be kept as smooth as a telephone pole ten to fifteen feet high as is so often the case.

Some of the details of pruning were mentioned on pages 225 and 226.

PRUNING ACCESSORIES.

For cutting limbs too large for the pruning shears, a pruning saw should be used. There are several types of good narrow bladed pruning saws on the market. The ax is not a pruning tool yet some people mistake it for such and use it accordingly with bad results. A pruning knife makes a better cut then the hand pruning shears because the latter bruises one side of the limb at each cut, but it can be used so much more rapidly that it is preferable to a knife. The long handled pruning shears are especially useful.

Ordinary step ladders or other similar kinds are better than those which rest against the tree and bruise or break the bark. In climbing through a tree care should be taken not to skin the limbs. All skin breaks should be painted like pruning wounds.

One or two horse wagons are often equipped with high boxes with moveable extension planks at each end so the pruner can reach the limbs to be removed. Two men can work very rapidly on one of these rigs.

PROPAGATION.

The apple is propagated by grafting or budding on seedling stocks. The seeds are planted in well prepared seed beds and the seedlings are dug in the fall and are heeled in or so handled that the roots keep moist either in sand, moss or other material.

Root or bench grafting is done during the winter and the grafts are planted in the spring about eight inches apart in nursery rows four feet apart.

The seedlings to be budded are planted in nursery rows in the spring like root grafts and are shield budded in August or September when the bark peels readily.

GRAFTING AND BUDDING.

The two principal kinds of grafting used on the apple are the whip or tongue method and the cleft method. The whip or tongue method is used in root or bench grafting seedling roots and in top grafting young trees. (See figs. 5 and 6).

The roots and limbs to be grafted are known as "stocks" and the pieces of twigs or grafts three or four inches long which are placed on the stocks are "cions." Cions are always made of the past season's growth. Top working means to graft or bud the top of a tree.

In whip or tongue root grafting, the cion and stock are trimmed exactly alike. A smooth slanting cut is made across one end and a backward cut near the bark and parallel to the long side is made to form the tongue as shown in fig. 5. These ends are pushed tightly together crossing them slightly so the light colored layer of bark of the cion must come in contact with the light colored layer of bark in the stock

Fig. 5.—1—seedling apple stock. 2—cions. 3—the root prepared for whip grafting. 4—The cion prepared. 5—the stock and cion united. The hands show how to make proper cuts for whip grafting. (From bulletin No. 92).

Fig. 6.—4 and 5 are the same as 4 and 5 in Fig. 4. The lower right hand corner shows th waxed cord wrapped around the union. (From bulletin No. 92).

for it is here that the healing between the two takes place. The point of union is wrapped with wax cord to hold the cion and stock together and the grafts are packed away in moist sand, earth or moss for spring planting. If cloth is wrapped and tied over the point of union there will be less development of crown gall as mentioned elsewhere.

Top grafting by the whip or tongue method is done just like root grafting except that the cions are grafted on limbs cut back to about three inches and all cut places are well covered with grafting wax. All top grafting is done in the spring and the cions must be perfectly dormant.

In cleft grafting the cion is trimmed to a wedge shape with one side a little thicker than the other (see fig. 7) so that when it is set in the

Fig. 7.—1—cleft in limb and graft set in place. 2—grafting mallet. 3—Two cleft grafts trimmed for use. 4—grafting chisel. 5—bundle of cions. (From bulletin No. 92).

cleft, with the thick edge out, the pinching of the cleft will hold it in position. It must be placed so that its white layer of bark comes in contact with the white layer of bark of the stock, crossing these a little is best. The limb is sawed off and trimmed smoothly and the cleft or split is made with a grafting chisel as shown in fig. 7. In limbs more than one and one-half inches in diameter it is best to insert two cions, one at each side of the cleft. If both grow one may be cut out after a

year or two (see fig. 8). All cut surfaces must be well covered with grafting wax.

Budding is done in June or September when the bark peels readily. "Bud sticks" are twigs of new growth with the leaves cut off leaving half an inch of the leaf stems. The leaves must be removed as soon as the bud sticks are cut from the tree to prevent drying them out and they must be kept in a moist wrapper.

Fig 8.—One year's growth from cleft grafts, two cions in each cleft. (From Bulletin No. 92).

Shield budding is done as follows: make a T-shaped cut in the bark of the stock where it is desired to place the bud. Take the bud stick in the left with the butt pointing downward or outward, begin cutting half an inch below the bud and run the knife beneath it and half an inch above. Take hold of the leaf stalk and slip the bud into the T-

shaped cut on the stock and wrap tightly with moist raffia or coarse soft cord (see fig. 9).

About ten days after budding has been done, the wrapping is cut with one slip of the knife on the side opposite the bud. The September buds remain dormant until spring when the stock above the bud should be cut away to allow only the inserted bud to grow. When June budding is done part of the stock above the inserted bud is cut away at once and the balance later when the bud begins to grow.

Fig. 9.—Bud stick showing how to cut the buds.
B—Bud ready for use.
C—The T-shaped cut in the stock and bud partly inserted.
4—The bud in place and wrapped.
(Drawing by Ballard.)

GRAFTING WAX.

Grafting wax is made of 4 parts rosin, 2 parts beeswax and 1 part tallow. Melt the rosin and let it simmer a few minutes then add the beeswax shaved fine. Let these simmer a few minutes, add the tallow and after a few minutes boiling pour into cold water. Grease the hands

with tallow and work and pull the wax like molasses candy is pulled until it takes on a smooth elastic grain like rubber gum. Mould into balls or sticks and wrap in greased paper.

If the weather is cold when grafting is done the grafting wax must be kept in a bucket of hot water to make it soft and flexible. The one who uses the wax must have his hands well greased with tallow to prevent the wax sticking to them.

Liquid grafting wax is made by melting together one pound of white rosin and one ounce of tallow; remove from the fire and stir while pouring in slowly eight ounces of wood alcohol. Pour in bottles and cork securely. Apply with a brush.

GRAFTING CLOTH.

Lay old calico cloth on a board or table and spread melted grafting wax on one side. Let it dry and tear into strips for use.

GRAFTING CORD.

Grafting cord is prepared by dipping balls of knitting cotton until saturated into melted grafting wax. Let the surplus wax drain out and the cord is ready to use.

TOP WORKING YOUNG AND OLD TREES TO OTHER VARIETIES.

The best practice in starting an orchard is to plant strong growing trees like Red Astrachan, Northern Spy or Tolman Sweet, and top work with cions from the very best trees of the varieties desired. By doing this a uniform set of trees of known parentage will be secured. The top working may be by whip grafting or budding just before the trees are planted or two years later. The writer has had good success in whip grafting nursery trees and planting at once. If two-year old trees are used, from three to five grafts are necessary, but in one-year olds a single graft will suffice. If a cion fails to take, shoots will grow from the limb and one of these may be budded the following June or September thus keeping the growth symmetrical.

The knife used in preparing the cions and stocks must be kept sharp so as to make smooth cuts.

Older trees are either cleft grafted at once to change the variety, or most of the top is cut off to force out new shoots which are either budded or whip grafted, and a new bearing top is soon secured. Old high tops may be cut back in this way and new low tops grown instead. Cleft grafts one year old are shown in fig. 8.

PROTECTION FROM MICE AND RABBITS.

One of the best protectors is made from half inch mesh galvanized wire screen cut to the proper length and width and rolled around the trunk. If the trunks are so short that rabbits will reach above the pro-

tector then a shot gun should be used. All rubbish should be scraped away and an earth mound a foot high should be made around each tree late in the fall.

REMOVING FILLERS.

As soon as the fillers begin to crowd the permanent trees they must be taken out. They need not be all removed at one time, but only as necessary leaving those in the squares between each four permanent trees to the last. It takes nerve to dig out bearing trees twenty years old and only first class fruit growers will do it.

DWARF TREES.

It is doubtful if dwarf trees are profitable for commercial orchards or even for fillers among standard trees. They have their place in gardens around city, town and suburban homes and are highly recommended for such places or wherever space is limited. Those on doucin stock should be planted 10 or 12 feet apart each way. The very dwarf trees on paradise stock can be set 6 or 8 feet apart each way. So little room is required that anyone having a few square rods of land may have fifteen or twenty varieties of apples which will furnish a good home supply from the first part of July until Christmas or later.

The trees need the same care in planting that standard trees do, but should be looked after more carefully during the growing season. Dwarf trees are most satisfactory horticultural toys.

What varieties will do best cannot be stated here, but the entire "home use" list mentioned elsewhere is suggested for trial. Not all of these can be obtained in the nursery but the trees are easily top worked to whatever is desired.

HARVESTING THE FRUIT.

The fruit should be most carefully hand picked when fully grown and well colored. The hand should grasp the apple cautiously with the fore finger at the stem and by a rolling and bending movement unjoint the stem from the fruit spur. Apples should not be grabbed and jerked off like objects for immediate destruction nor should they be shaken down or clubbed off as though they are out of place on the trees. Careless picking destroys many fruit spurs and injures the fruit by bruising. If the stems are pulled out or the skin broken or flesh bruised in any way, the fruit will not keep well and its value is reduced. Apples should be as carefully handled as eggs and be picked with stems on and without any bruising whatever.

A padded half-bushel basket with swing handle is a good receptacle into which to place the fruit as it is picked. A wire hook on the handle is convenient for hanging the basket on the limbs. Sacks tied together at the upper corner of each end and swung over the shoulder are much used, but they offer too much opportunity for bruising the fruit. The

fruit grower must adopt whatever answers his purpose best. (See half bushel basket, fig. 10).

Fig. 10.—Half bushel picking basket. (After Waugh in The American Apple Orchard).

SORTING TABLES.

Sorting tables of various styles are used and one to answer the purpose can be easily made. Strong legs and side bars are necessary and a burlap or canvas bottom is best. Some growers pick into the Delaware peach baskets and grade from these baskets without using a sorting table. A western table used in box packing is shown in fig. 11.

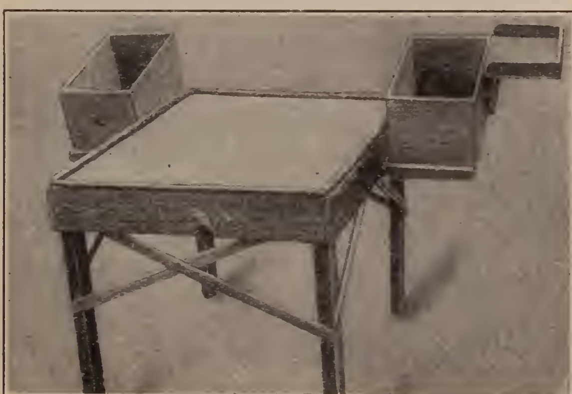


Fig. 11.—Sorting Table. (Courtesy of Fruit Growers' Association of Adams Co., Pa.).

GRADING AND PACKING SUMMER VARIETIES.

There are usually only two grades of hand picked summer varieties the first and second, and these differ with different growers. The first

grade includes all sound fruit above two inches, or perhaps slightly less, in diameter, and the second grade includes the smaller sound fruit. Windfalls are graded the same way with respect to size.

The customary shipping package in Maryland is the bushel basket with cover. This is the same shape as the Delaware peach basket. The bushel box should be used for the choicest varieties. If barrels are used the fruit should be as carefully and properly packed as mentioned for winter apples.

GRADING AND PACKING WINTER VARIETIES.

The winter varieties should be divided into at least four grades—first for boxes, first for barrels, second for barrels, and culls. All first grade fruit should be two and one-half inches or larger in diameter except the small fruited varieties and with these this grade may include medium size and above. No blemished or bruised fruit is allowed in this grade. That which goes into boxes must be of fine finish, high in

Fig. 12.—Grown and packed on the Delaware-Maryland Peninsula. (From Bulletin No. 116).

color and even in size. The first grade barrel stock must also be free from blemishes and bruises and ought to be of about the same size in each barrel, that is, medium and large sizes ought not to be mixed in the same barrel. This grade presents a better appearance if the apples in each barrel are nearly the same size. Second grade fruit includes that from two and one-quarter to two and one-half inches in diameter and sound and free from blemishes. The culls include all of the rest

and usually ought not to be sent to market to compete with the better grades. The best culls ought to be used for evaporating and canning stock.

The very best fruit should be packed in bushel boxes as it is in the West. The commission men and city dealers advise against the bushel box for eastern fruit because there is not as much money in it for them as there is in the barrel, but nevertheless, the box should be used and forced onto them. It is certainly the coming package for fancy eastern apples. A bushel box of Peninsula grown and packed fruit is shown in fig. 12.

The standard box of the West is 10½x11½x18 inches inside measurement. This box will accommodate the commercial sizes better than a box of any other dimensions. For large apples the western growers use the California special box 10x11x20 inches inside measurement. The ends are ¾ inch thick, the sides ⅜ inch, and the top and bottom ¼ inch. There are cleats on the ends of the tops and bottoms.

The art of packing apples in boxes is not easily described in writing, it must be learned by teaching and practice. Plates I and II from "The American Apple Orchard" by Waugh, represent a few methods of packing apples of different sizes, but are a little misleading in that the apples are not made to touch each other. There are no spaces between the apples and each layer fits snugly into the box. The fruit in each box must vary but little in size and the largest must be placed in the centre to make a bulge as shown in fig. 13. When the box is packed

Fig. 13.—Side view of boxes after nailing, showing proper bulge of top and bottom. (Courtesy of Fruit Growers' Association of Adams Co., Pa.).

the fruit at the ends projects slightly above the top and at the centre about an inch above. See fig. 14. When the nailing press draws the ends down for nailing, the bulge is divided between top and bottom and every fruit is held firmly in place. A packed box should be laid

on its *side* and never on the top or bottom or the fruit will be bruised.

Plate I, fig. 1 shows how to pack apples of such size that six rows of four apples each will just fill one layer. There are four layers just alike which make 96 fruits per box.

Fig. 14.—Left box is too flat, middle box is just right, right box is too high. (Courtesy of Fruit Growers' Association of Adams Co., Pa.).

Plate I, fig. 2 is similar to the above except that there are 32 apples in one layer and 128 in the box.

Plate I, fig. 3 shows seven rows with five fruits in a row in each layer. There are five layers of these making 140 apples to the box.

Plate II, fig. 4 represents small apples 50 in a layer and 250 to the box.

Plate II, fig. 5 is a different style of pack with three apples in the first row across the box, two in the second, and three and two alternating to complete the tier. The second tier starts with two apples in the first row placed in the intervals between the three in the bottom row, three in the second, etc., alternating as in the first tier and breaking joints with the first tier. The third tier is just like the first, the fourth like the second, and the fifth like the first, making 213 apples in the box. This style of pack is also used for 188 and 200 fruits per box.

Plate II, fig. 6 shows the bottom layer of a pack with three apples in each row alternating with the row ahead. Each tier alternates with the tier below so that the apples in the third tier are directly above those in the first tier and the fourth tier is exactly above the second. Seventy-two apples fill the box.

The number of apples each box contains, the name of the variety and the grower's name, should be stamped on one end of the box. A neat and attractive label pasted on one end adds to the appearance of the package and is a good investment.

These are only a few of the ways to pack boxes and will serve as a guide. A fuller discussion with illustrations of apple box packing will be found in Bulletin No. 94, of the Oregon Agricultural Experiment Station, and in "Better Fruit" published in Hood River, Oregon.

The proceedings of the Fifth Annual Convention of the Fruit Growers' Association of Adams County, Pa., held in December, 1909, include a most instructive address by Mr. C. C. Vincent, Assistant Horticulturist of the Oregon Agricultural College, on box packing of apples. These instructions are so clearly given that a few paragraphs are quoted in full as follows:

FIG 1.

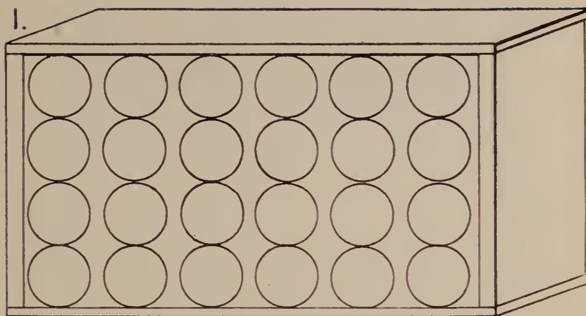


FIG 2

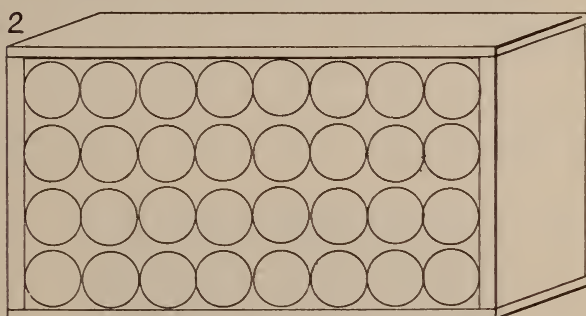


FIG 3

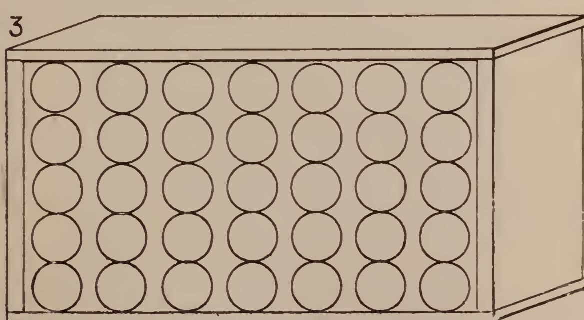


Plate I.—Shows different styles of packing fruit in bushel boxes. (After Waugh in The American Apple Orchard).

FIG 4

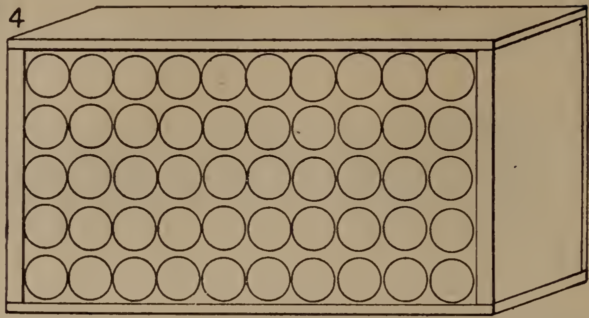


FIG 5

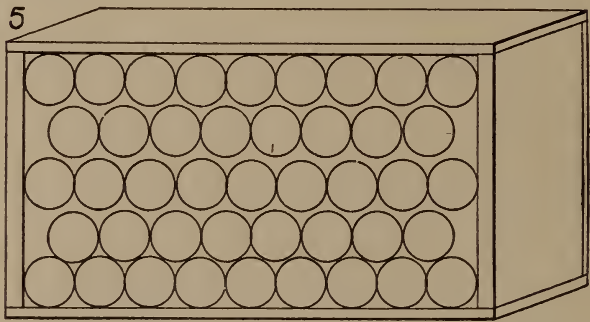


FIG 6

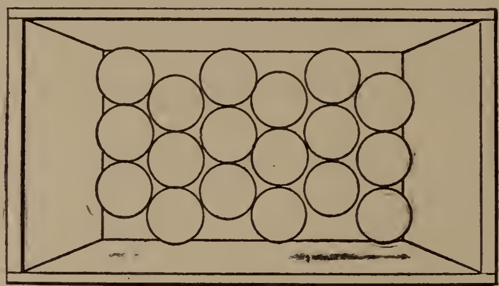


Plate II.—Shows different styles of packing fruit in bushel boxes. (After Waugh in The American Apple Orchard).

GRADING.

"The apples, on their arrival at the packing house, are placed at the ends or in the center of the building. A crew of men begin immediately to sort the apples. I have here a sizing board (shows board about six inches wide and two feet long, with a row of holes through the center, varying in diameter from 2⅜ inches to 3⅜ inches in regular sequence), which represents the different sized apples that are put up in boxes. This board (see fig. 15) is placed up in a convenient place, before the sorters. As soon as the grader has trained his eye, and this it will not take him long to do, he will be able to discard the grading board for

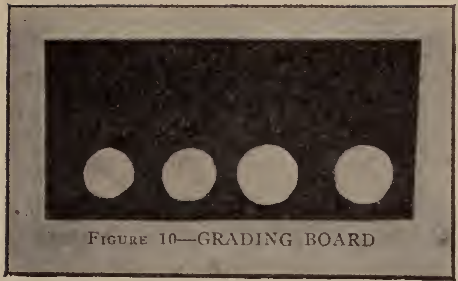


Fig. 15.—Grading Board. (Courtesy of Fruit Growers' Association of Adams Co., Pa.).

the most part, and can tell at a glance if a certain apple is going to fit in a certain pack. If in doubt, he holds the apple up to the hole, but never drops it through. Some men, the grower finds, soon adapt themselves to this method and become very proficient graders. But, just as you have found in barreling, some men will never learn how."

STYLES OF PACKS.

"At the present time there are two styles of packs, known as the square, or straight, and diagonal pack. In the square pack the apples are placed one upon the other. In the diagonal pack (see fig. 16),

Fig. 16.—Celebrated Diagonal Pack. (Courtesy of Fruit Growers' Association of Adams Co., Pa.).

there is less danger of the apples bruising in transit, as no one apple rests upon another, but fits in between the four apples below. Undoubtedly before many seasons pass, the diagonal pack will be the one most largely used. If only the two sized boxes were used, all apples could be packed diagonally. For instance all the apples that would pack square in the California box, could be packed diagonally in the Standard box. The three tier, four tier, and five tier apples will pack up in the square pack. The three and one-half tier, four and one-half tier, can be placed in the diagonal pack."

"The classification of the apples contained in each box, as is designated by the tin labeling, is as follows:

3 Tier Apples in the Standard box, 45 to the box.
3 Tier Apples in the Special box, 54, 63.
3½ Tier Apples in the Standard box, 64, 72, 80, 88.
3½ Tier Apples in the Special box, 96, 104, 112, 120.
4 Tier Apples in the Standard box, 96, 104, 112, 120.
4 Tier Apples in the Special box, 128, 144.
4½ Tier Apples in the Standard box, 150, 163, 175.
4½ Tier Apples in the Special box, 185, 200.
5 Tier Apples in the Special box, 200, 225.

Unless the apples have been properly graded beforehand, no such system of classification can be obtained. Probably the best place for the 5 Tier Apples, is at the evaporator or cider factory."

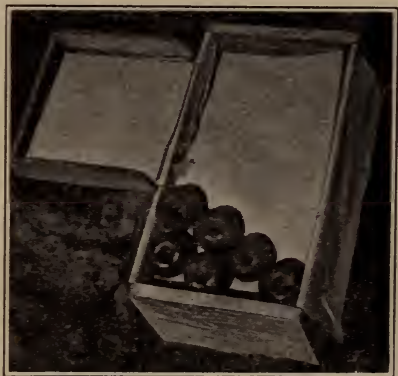


Fig. 17.—Method of starting 3½ Tier Diagonal Pack. (Courtesy of Fruit Growers' Association of Adams Co., Pa.).

STARTING THE PACKS.

"Very little trouble will be experienced in starting the square pack, i. e., if the apples have been properly graded. With the Three Tier Apple, which is three and three-eighth inches in diameter, it requires three apples to fill up the space across the bottom of the box, or in other words there will be three rows in width and three layers in

depth. The Four Tier Apples require four rows in width and four layers in depth."

"The diagonal Three and one-half Tier pack (see fig. 17) is started differently. In this style one gets three and one-half rows in width and four layers in depth. The first apple is placed in the lower left hand corner of the box, another apple is placed in the center. The fol-

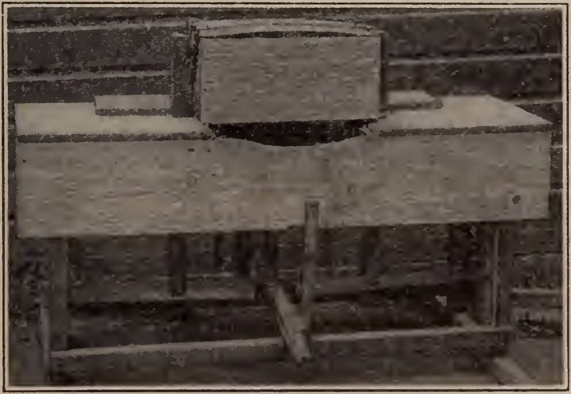


Fig. 18.—Nailing Press. (Courtesy of Fruit Growers' Association of Adams Co., Pa.).

Fig 19.—Specimens from a fraudulently packed barrel of apples. (From Bul. No. 116).

Fig 20.—Specimens from an honestly packed barrel of apples. (From Bul. No. 116).

lowing two apples are pressed firmly in the places which are left. This is sometimes called the two by two pack."

"To start the Four and one-half Tier pack, place the first apple in the lower left hand corner of the box, another in the lower right hand corner, and another in the center. Two apples are then pushed down, as far as possible in the spaces that are left vacant. The Four and one-half Tier pack is also known as the three by two pack."

THE BULGE.

"Inexperienced packers will have some little difficulty in getting the proper bulge to the box. Practice, however will obviate this. When the fruit is packed, the apples at both ends should come up flush with the top. In the center they should extend a little higher. (See fig. 14). There is more or less of a gradation between one sized apple and another. For instance, between the Three Tier and Three and one-half Tier. To obtain the proper bulge, which should be from one to one and one-half inches, the packer selects apples that are a trifle smaller for the ends, working those that are a tirfle larger to the center. In case the apples are of the same size and are being packed on the cheek, in order to obtain the proper bulge, the end apples are turned with the stem ends up. Every box full should have a swell. (See fig. 13). As soon as the box has been filled it is taken to the nailing press (see fig. 18) and the cover placed on."

BASKET AND BARREL PACKING.

A good handle basket holding about a peck of apples ought to become a very popular retail package if it could be generally introduced.

The barrel will continue to be the most popular package for the eastern grower for some time to come, and properly used it is a splendid package, but unfortunately it is abused by dishonest growers and packers who fill the centre with small, wormy, diseased and worthless fruit. (See figs. 19 and 20). The standard American three bushel barrel measures 17¼ inches across the top 23⅓ inches across the centre, has staves 28½ inches long and holds 100 quarts. Barrels of smaller dimensions are "snide packages" and should not be permitted on the market, they are meant to deceive the public and are an injury and disgrace to reputable fruit growing.

To pack a barrel, take out the bottom head and stand the barrel with top head down so as to pack the top end first. Lay a corrugated paper or cushion head protector in position, cover with a fancy paper cap and place a layer of "facers" stem ends down in circular rows fitted tightly together. (See figs. 21, 22, 23 and 24). A second layer of facers is similarly placed breaking joints with the first layer. The facers are of exactly the same grade as the balance of the apples in the barrel, but are selected because of their high color. This is allowable and is expected and is not a deception. The barrel presents a better appearance upon taking out the top head if the facers are well colored. Over the facers pour very carefully about half a bushel of apples at a time and shake the barrel cautiously but vigorously each time to settle the fruit firmly together. Fill the barrel to just above the end of the staves and face the top layer stem ends up. A padded head to prevent crushing the upper fruits may now be laid on and forced down carefully before putting in the head, or the head may be placed on at once and be pressed down into the chime. The hoops are then driven down and the head

Fig. 21.—A well packed barrel of apples. (From Bulletin No. 116).

Fig. 22.—Fancy paper trimmings. (From Bulletin No. 116).

Fig. 23.—Paper cap and fancy trimmings. (From Bulletin No. 116).

is nailed in. The grade, name of variety and grower's name should be stamped on the top head.

The screw barrel press, fig. 25, is one of the best.

STORING APPLES.

The old custom of piling fall and winter apples in the orchard to let the sun color them has only one reason for being practiced and that is to hasten the ripening of fruit for immediate use.

Apples so handled will not keep as long in ordinary or cold storage as those packed and placed in cold storage as soon as picked. Apples will keep best if rushed into cold storage at the earliest possible moment after picking. If the grower has such a storage place at hand he can take the fruit there as soon as picked and grade and barrel at his convenience. Those who must depend on city cold storage should grade and pack at once and ship to cold storage daily if the weather is mild

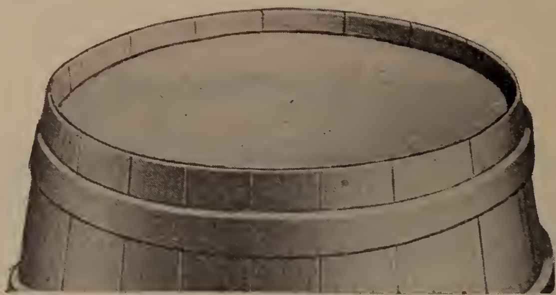


Fig. 24.—Corrugated paper cap to protcet the fruit. (From Bulletin No. 1116).

or warm. If the weather is cold when picking and packing are going on, less damage to the fruit will result from delayed storage.

Local cold storage plants for winter apples in Maryland are not at present really necessary for it is better to ship at once to city storage warehouses in the fall so the fruit may be placed on the market at a few minutes notice when the best prices prevail during the winter. This makes the fruit grower more independent than he would be if he had to ship during cold winter weather from his local storage to the city markets. Local warehouses would be very valuable, however, for holding summer apples, peaches and other fruits.

ORCHARD HEATING.

The next great step in progressive eastern horticulture will be orchard heating. This is practiced successfully in the inter-mountain district of the West and on the Pacific Slope. About 100 smudge pots are required per acre, these cost from 20 cents to 30 cents each. Crude oil and soft coal are the forms of fuel used. The Experiment Station will start some work in orchard heating this spring. Those interested will find different makes of orchard heaters advertised in horticultural periodicals.

SELECTING APPLES FOR EXHIBITION PURPOSES.

Until recently the largest and most overgrown specimens of apples received first premiums at the county and state fairs, horticultural society exhibitions, etc. This has now been very sensibly changed to favor commercial sizes and at the great national expositions the large specimens of a variety stand very little chance of winning a premium. Select fruits according to the following instructions:

Slightly above medium size for the variety.

Fruits of absolute uniformity in size and shape.

Fig. 25.—A good type of screw press used in heading up apple barrels. (After Waugh in The American Apple Orchard).

Fruits of typical shape for the variety.

Five fruits for an exhibition plate of apples.

Color uniform and the higher and richer the better.

A whole stem in every apple.

Entire freedom from blemishes.

The loss of a stem, a break in the skin, a disease or insect mark, a bruise, frost or spray injury, these are all blemishes.

Any one of the following apparently trivial defects have caused otherwise perfect plates to lose premiums,—one apple too large or too small, one apple not quite typical in shape, the loss of one stem, a light spot where there should be solid red color, or a small disease spot or insect blemish.

The rubbing and polishing of exhibition apples should not be allowed. and cannot be too strongly condemned.

VARIETIES.

The question of selecting varieties for any locality is a serious one and mistakes cannot be made because too much depends upon the outcome of the crop. The writer will not recommend varieties low in quality without offering proper explanation because he believes that fruit growers should be encouraged to produce only the best, that consumers should be taught to use nothing but the best, and that there will be more profit and satisfaction in the long run in growing none but the best. Such varieties as Ben Davis and York are usually profitable and there are people who like them, but even admitting all of this the writer still claims that the most progressive fruit growers should plant only the best quality varieties.

It may be that some varieties grown locally are not mentioned in the following lists, however, if these are satisfactory to the grower he had better continue to grow them.

There are so many good varieties which succeed in Maryland that it is difficult to give every one proper recognition.

A general list for home use and local market would cover the entire State except Allegheny and Garrett counties where a change in winter varieties is necessary. This general list follows arranged in the order of ripening:

Yellow Transparent.
Early Ripe.
Early Harvest.
Red June.
Early Strawberry.
Red Astrachan.
Williams.
Chenango (Strawberry).
Summer Rambo.
Sweet Bough.
Jefferis.
Mother
Benoni.
Maiden Blush.
Fall Pippin.
Bailey Sweet.
Gravenstein.
Wealthy.
Grimes.
Bloomfield.
Domine.
Whitney Russet.
Jonathan.
Rome.
Stayman Winesap.
Winesap.
Nero.
Paragon.

For Allegheny and Garrett counties the last six varieties should be replaced by Fameuse, McIntosh Red, Tompkins King, Twenty Ounce, Baldwin, Rhode Island (Greening), Northern Spy, Yellow Bellflower and Wagener.

Commercial lists will not vary much over most of the State except according to the taste of the grower. The farther south the summer varieties are grown the earlier they will ripen and the more profitable they will be. However, even in the northern tier of counties clear across the State these varieties are very valuable.

The group of most profitable summer varieties includes Yellow Transparent, Early Ripe, July and Williams of which the Williams usually brings the highest price. These make a succession of ripening for about four weeks. The Red Astrachan comes in with July and is popular with some growers. Its principal faults are uneven ripening and bi-ennial bearing. The Early Harvest can be made profitable with good cultivation and spraying. Red June ought to be very profitable because of its high quality and bright red color. It attains good size where well cared for.

The next group will include Summer Rambo, Maiden Blush, Mother and Fall Pippin. These will probably not be as profitable as the first group, but are mentioned to fill in the season and will succeed in any part of the State.

Following these is another group of four of the best late fall varieties, Gravenstein, Wealthy, Bloomfield and Grimes. These are very profitable for the entire State and extend the season to the early winter varieties.

All of the varieties in the three groups just mentioned ripen in southern Maryland and the southern part of the Eastern Shore from two to four weeks earlier than in Western Maryland, but as the market demand for them is continuous they are all profitable.

There is considerable difference of opinion regarding winter varieties and much is yet to be learned with respect to their adaptability to different sections. It is best to have only three or four winter varieties rather than six or eight. For all of the State except Garrett and Allegheny counties and perhaps the highest sections of Washington county, the Jonathan, Stayman Winesap, Paragon, Winesap, Rome and Nero are in the opinion of the writer the very best. These should all be given a thorough trial in the mountainous sections of the counties just mentioned where the old northern varieties like Tompkins King, Twenty Ounce, Rhode Island (Greening), Spy, Yellow Bellflower and Baldwin are the favorites and are well adapted.

The McIntosh, Cox Orange, Delicious, Winter Banana and King David ought to be thoroughly tested throughout the northern row of counties across the entire State.

DESCRIPTIVE LIST OF VARIETIES.

During the past three years no less than 151 named varieties of Maryland grown apples have been exhibited at the annual exhibitions of the Maryland State Horticultural Society. Besides these there were a

dozen or more unknown varieties. If 126 of the named varieties and all of the unknown ones could be suddenly discarded and be replaced by the 25 selected varieties remaining, the apple industry of the State would be in a greatly improved condition. Brief descriptions are given of 85 varieties which include 4 varieties recommended for trial, but the names of the other 70 are not important enough to be divulged.

Alexander—A large Russian early winter apple, flatttened conic, mostly red or red striped, fair quality, does well in cold sections but will probably not be extensively planted.

Arkansas Black—A medium sized winter apple, nearly round, almost solid black in color, very attractive, fair quality, hardy, winter, will not be much planted.

Bailey Sweet—Large, attractive red striped or partly solid red, good quality, sweet, good for home use or local market, late fall.

Baldwin—An old standard winter variety of medium quality probably more grown than any other variety in cold sections but not always hardy. It is of value in Maryland only in the mountainous districts.

Beach—Medium, roundish flattened, shaded and striped with red and carmine, fair, winter, not recommended.

Ben Davis—Attractive in appearance when well grown, red striped, poor quality, above medium size, good bearer, winter, is still profitable to grow but better varieties should be planted.

Beitigheimer—Very large, purple red, tart, fall variety, ripens unevenly and drops badly, not worth planting.

Benoni—A small red apple of fine quality, excellent for home use but too small for commercial planting, early fall.

Bismark—Above medium size, red striped, poor quality, very early bearer as a dwarf, not recommended, early winter.

Black Ben Davis—Much like Ben Davis except it is a little longer and smoother in outline, very dark solid red color, fragrant, not so poor in quality as Ben Davis and is to be preferred to that variety, winter.

Bonum—Medium size, dark red or striped, oblate, fine dessert apple for home or local market, annual bearer and productive, late fall.

Buckingham—Medium to large, oblate or slightly roundish, somewhat irregular, yellow mottled and striped with red and carmine, good quality, good for home use.

Chenango (*Chenango Strawberry*)—Small to above medium size, long pointed, whitish skin striped with red, good quality, very productive, ripens unevenly during a period of three or more weeks thus being especially good for home use and local market, early fall.

Colton—A small, round, greenish bronzed summer variety ripening with Yellow Transparent and Early Ripe, too small, not recommended.

Cox Orange—An old English variety, medium size or above, slightly conic, red striped, one of the best in quality, winter. This should be tested in the northern tier of counties especially in the western part of the State.

Dominie—Medium size or above, flattened or slightly conic, greenish or yellowish striped with red, good quality, productive, early winter.

Early Harvest—Medium or above in size, greenish yellow, good quality, needs spraying and cultivating, good bearer when well cared for, fine for home use, almost as early as Yellow Transparent, probably suceeds best on Eastern Shore and Southern Maryland.

Early Ripe—Medium size, flattened, hard flesh, good quality, extra good shipper and market variety, very productive and profitable, ripens with Yellow Transparent.

Early Strawberry—Small size, red striped or nearly solid red, extra good quality, fairly productive but late to come into bearing, good for home use or local market, follows Early Ripe.

English Red Streak—This is probably "Wells." Fruit large to very large, roundish slightly conic, yellowish streaked and blotched with red, good, late fall or early winter.

Esopus (Spitzenburg)—One of the highest in quality, often shy bearer, medium size or above, irregular in shape, roundish ovate slightly conic, red, should be top worked on a strong growing variety like Red Astrachan or Northern Spy. Good for Western Maryland, winter.

Delicious—Medium to large, attractive, red striped or nearly covered with red, conic or long drawn out with prominent knobby ribs at blossom end, ribbed, pleasant rich flavor but almost too sweet, winter. Said to succeed where Northern Spy does but should be tried throughout the entire State.

Fallawater—Large to very large, greenish sometimes with blush, poor quality, winter, not recommended.

Fameuse—Small to medium, good quality, nearly red, early winter, would do best in Western Maryland but there are better varieties.

Gano—An improved Ben Davis but a little flatter in shape and of a nearly solid red color, winter.

Gloria Mundi—A very large, irregular, yellow winter variety, not recommended.

Golden Russet—Medium size, roundish, good quality, winter, good for home use.

Gravenstein—Above medium size, flattened or roundish, mostly red or red striped, very productive, very good quality, late fall, ought to be more generally grown for market.

Green Newtown—This is similar to Yellow Newtown except that it is of a greener color, both are of high quality.

Grimes (Golden)—Medium to large, roundish or cylindrical, flattened at ends with large cavity and basin, yellow, one of the best in quality, late fall. The fruit should be put in cold storage and held for Thanksgiving and Christmas trade. Nursery grown trees of this variety are seldom long lived, they usually die at from 15 to 25 years of age. Strong growing varieties with healthy trunks like Red Astrachan, Tolman Sweet or Northern Spy should be planted and top worked to Grimes. This is one of the best of its season for Maryland.

Haas—Medium or above, oblate, red striped with carmine, fair quality, productive, early winter, not recommended.

Holland Winter, (Incorrectly *Holland Pippin*)—medium to large, roundish conic, whitish or pale green often with faint blush, good, late winter, productive.

Hoover—Medium to large, roundish, dark red almost black with prominent light colored dots, quality poor, not recommended.

Hubbardston—Medium size, conic, red mottled and striped, good quality, good bearer, early winter, would probably do well in Western Maryland.

Jefferis—Small to medium size, oblate, red striped, excellent quality, good bearer, especially good fall variety for home use.

Jonathan—Medium or slightly above, roundish conic or roundish ovate, light to dark red, uniform in size, rich spicy flavor, excellent quality, early winter, trees have slender twigs and grow slowly at first, productive. The writer has heard one complaint of its blighting and one of its having a tender trunk thus requiring to be top worked on a strong grower like Red Astrachan or Northern Spy. This is certainly one of the best varieties for all parts of the State except Garrett and Allegheny Counties.

July—Medium to large, roundish conic, greenish or white somewhat striped with red, fairly good, tree strong grower, productive, follows Yellow Transparent in season.

King David—Medium or above in size, oblate slightly conic, dark red, good, early winter. Worth trying all over the State but may not succeed in all sections.

Kinnaird—Small to medium or above, oblate slight conic, rich dark red, good, not much grown.

Lady—Very small, yellow with red cheek, good quality, winter, grown for fancy trade and for decorations.

Lankford—Medium to very large, usually lop-sided, dull red, good quality as grown on the Eastern Shore, productive, early winter, not desirable.

Lawver—Medium to large, bright solid red, productive but drops badly, very late winter variety, fair quality but improves as it ripens in spring, keeps until July in cold storage. If a very late keeper of fairly good quality is desired this may be used.

Limbertwig—Small to medium size, dull red or striped, fair quality, late winter, productive, not recommended.

Lowland Raspberry (*Liveland Raspberry*)—This variety should be tested in Maryland, its season is about two weeks later than Yellow Transparent. The fruit is medium or above in size, roundish, waxy white with rosy red blush or stripes, very attractive, fine grained and good.

McIntosh—Medium size or above, roundish, attractive red, fine grained, pleasant perfume, very good. The tree is very hardy and should be a valuable early winter variety for Western Maryland, belongs to the Fameuse group.

Maiden Blush—Medium or above, oblate, yellow with bright red blush, very good quality, one of the best known fall market varieties.

Missouri Pippin—Small, roundish, ends sometimes flattened, often slightly oblique, rich red striped and shaded, poor, early winter, very prolific and bears early. Much used as a filler, not recommended.

Mother—Medium or above, roundish conic, nearly covered with dull red, splendid dessert variety, fairly good bearer, late fall. Ought to prove valuable for Maryland.

Nero—Medium or above, oblate, striped or nearly covered with red, fair to good quality, annual bearer and very productive of even sized fruit, winter, is one of the most profitable varieties on the Maryland-Delaware Peninsula.

Nickajack—Large, roundish, uniform in size, attractive, dull grayish—red striped, solid flesh, fair quality, very late winter, keeps in cold storage until July and then sells at high prices, trees are late to come in bearing but then bear annually.

Northern Spy—One of the old standard northern winter varieties of best quality well adapted to Western Maryland, but is of little value in other parts of the State where it ripens in the fall, drops badly and is of poor quality.

Northwestern Greening—Large to very large, roundish to oblong, slightly conic, greenish or yellow, fair to good quality, productive, early winter, tree very hardy and a good one for top working to weak varieties like Grimes.

Oldenburg (*Duchess*)—Medium size, usually flattened, attractive, red striped, splendid cooking apple because of acidity, productive, hardy Russian variety, is especially valuable for Western Maryland.

Ortley—Medium to large, oblong conic to round conic, pale yellow, flesh tender, good, not recommended.

Paragon (often called *Mammoth Black Twig*)—Medium or above, uniform in size, oblate slightly conic, almost covered with dull red nearly black, late to come into bearing but is then productive, good to very good, late winter, very valuable for Maryland.

Pennock—Large, roundish flattened, dull red, fair to good, winter, not recommended.

Pewaukee—Large, roundish with cavity nearly closed, bright or dull red striped, fair quality, tree hardy and good cropper, winter, not recommended.

Ralls, (*Jeniton, Ralls Janet*)—Small to medium, roundish to slightly flattened or conic, dull greenish with dull red striping or solid red, good quality, very productive, should be thinned or fruit is very small, good for home use, winter.

Rambo—Medium, roundish flattened, pale yellow more or less mottled or striped with red and roughened with russet dots, very good quality, early winter, good for home use.

Red Astrachan—Medium or above, roundish, pale yellow or greenish, partly covered with red or sometimes striped, flesh tender, tart, good, ripens unevenly two or three weeks after Yellow Transparent, biennial cropper. Tree is hardy and should be used as stock for weak growers like Grimes.

Red June—Small to medium, roundish inclined to conic or oblong, often entirely purplish red but sometimes striped, very attractive, flesh white, tender, very good, productive but not always an annual cropper, seems to do very well in Maryland and is a good to follow Yellow Transparent and Early Ripe.

Rhode Island (*Greening*)—Another old standard northern winter variety which does well in Western Maryland.

Rome (*Beauty*)—Medium to very large, one-half or more covered with bright red or red striped, attractive, roundish conic, bears early, very productive but fruits vary much in size many becoming too large, likely to drop badly if not picked at proper time, good, early winter. Properly handled this is a good variety for Maryland and will probably succeed well in the mountains.

Roxbury (*Russet*)—Above medium size, oblate somewhat conic but irregular; greenish more or less covered with yellowish-brown russet sometimes with bronze blush; good to very good quality, winter.

Shockley—Small conic, red striped or nearly red, fair quality, winter, not recommended.

Smith Cider—Medium to large, roundish to conic or oblong, mottled or striped with rich red and attractive when well grown, fair quality, early winter.

Smokehouse—Medium to large, roundish oblate, yellowish green marked with russet, partly covered or striped with dull red, good, usually prouctive, winter.

Stark—Medium to very large, roundish slightly conic, dull green or yellowish with little or much dull red blush, productive, biennial bearer, good quality, winter. Much subject to bitter rot and needs three or four extra sprayings.

Stayman Winesap—Medium to very large, oblate-conic to oblong-conic, often dull red but sometimes red splashed and mottled toward blossom end only. Flesh crisp, juicy, excellent, winter. Trees from the nursery come into bearing young and are productive of even sized fruit, but topworked trees are likely to produce fruit uneven in size for the first few years. This will undoubtedly be the leading winter variety in Maryland except in the western part of the State.

Summer Rambo—Large, oblate, green with red striping or solid red cheek, excellent for dessert and market, productive, early fall, tree vigorous and healthy, worth planting.

Tompkins King—Large, oblate-conic, nearly covered with bright rich red, excellent, winter, fairly good cropper, tree not very hardy, should be topworked on Red Astrachan or Northern Spy, good for Western Maryland.

Vandivere—Probably Newtown Spitzenburg—Medium, roundish cylindrical, striped with carmine and blushed with dull red, winter.

Twenty Ounce—Very large, rich yellow mottled or striped with bright rich red, roundish or roundish long conic, excellent, late fall, rather good cropper, tree trunk is weak and it should be topworked on Red Astrachan or Northern Spy, good for Western Maryland.

Wagener—Medium or above, oblate to somewhat roundish, often irregular, partly covered with pinkish red and carmine, excellent for dessert and market, early winter, tree rather weak but a fairly good cropper, should be topworked on a strong growing variety.

Walbridge—Medium or above, roundish conic, washed with red and striped with carmine, fair to good, early winter, not recommended.

Wealthy—Above medium, roundish-conic, smooth in outline, very attractive, rich red either in solid color or in splashes, good to very good, late fall or early winter, productive with good care, tree very hardy, grown principally in the western part of the State but ought to do well elsewhere.

Wine—Large, globular, red striped or nearly red, good, hardy and productive, winter.

Winesap—An old variety which does especially well in Maryland. Fruit medium or above, usually conic, very attractive rich but dark red, sometimes partly mottled with rich red, very good, winter, productive annual bearer with care, tree hardy with slender weeping twigs, does best on light soils, good for the entire State.

Winter Banana—Medium to large, oblate conic to roundish conic, often irregular, very attractive, rich light yellow with pink blush, good, early winter or late fall, productive. Worth trying throughout the State if a yellow apple of this season is desired.

Winter Paradise—Medium or above, roundish oblate, dull greenish yellow often with blush, sweet, winter.

Wolf River—Very large, flat at base, conic or roundish conic, very attractive, pale yellow blushed or splashed with bright red, tree very hardy and usually a good cropper, fair quality, early winter. Where such a large apple is desired this variety is usually profitable.

Yellow Bellflower—The old standard tart cooking apple but a rather shy bearer, succeeds in Western Maryland.

Yellow Newtown—Medium to large, roundish oblate, angular, often oblique, bright yellow sometimes with pink blush and clouded white at base, very best quality, late winter. This variety has not been grown enough in Maryland to determine its adaptability but where it succeeds it ought to be immensely valuable. It should be given a thorough trial in at least the northern tier of counties.

Yellow Transparent—Small to medium or above, conic, white when ripe, good, very productive. This is the first of the summer varieties to ripen and is picked in June in Southern Maryland and in the southern part of the Eastern Shore. It is a hardy Russian variety, succeeds over the entire State and is very profitable. It is quite susceptible to fire blight but seems to overcome this injury.

York (Imperial)—Medium to large, oblate to oblong usually oblique or lop sided, bright heavy red, very firm flesh, fair quality, heavy cropper, late winter. This variety succeeds well and is profitable but good fruit growers ought to plant varieties of better quality which will be even more profitable like Stayman Winesap and Jonathan.

COST OF STARTING AND MAINTAINING AN ORCHARD.

Most fruit growers do not keep records of the expense entailed year after year in caring for their orchards so it is impossible to state the approximate expense and profit of an orchard in most parts of the State. A set of questions was sent to several successful fruit growers in order to throw light on the expense of starting and maintaining an orchard, the crops grown while the trees were young, the age of first bearing, the age of first profit, the average value of crop and the value of heaviest crop.

The following detailed statement by Mr. E. P. Cohill, Hancock, of his seven year old thirty acre orchard is most valuable as a guide for Western Maryland. This orchard was handled as follows:

First year—Narrow strips cultivated along tree rows and cowpeas grown in middles.

Second year—Same as first year except that crimson clover was grown instead of cowpeas.

Third year—Same as second year.

Fourth year—All of the ground cultivated until August when red clover seed was sown.

Fifth and sixth years—Strips cultivated along tree rows and red clover left on middles until August when all of the ground was plowed and seeded to red clover.

Seventh year—All of the ground cultivated until August 15 when red clover seed was sown. Two hundred pounds per acre of a mixture of 12 per cent phosphoric acid and 5 per cent potash, were applied August 15.

Hogs were pastured in the orchard from May 1 to November 1 during the first six years. Mr. Cohill states that the manure and clover plowed under in this orchard have increased the value of the land at least twenty dollars per acre.

There are 3000 trees set 20 feet apart each way in the 30 acres. They were planted in November, 1902 and April, 1903. Labor is figured at 15 cents per hour.

Statement by Mr. E. P. Cohill, Hancock.

3000 trees	at 12c.		$ 360.00
Plowing before planting			72.00
1st year, 1903.			
Fertilizer and Tobacco Dust			25.00
Planting			63.00
Manure			75.00
Cultivating			215.00
Cowpeas and Clover seed			78.00
By Hog pasture		84.00	
2nd year, 1904.			
Cultivating			178.00
Manure			67.00
Pruning			12.00
By Hog pasture		96.00	
3d year, 1905.			
Cultivating			225.00
Manure			120.00
Pruning			26.00
By Hog pasture		100.00	
4th year, 1906.			
Cultivating			318.00
Manure			125.00
Pruning			12.00
Clover seed			17.00
By Hog pasture		171.00	
5th year, 1907.			
Cultivating			260.00
Manure			135.00
Pruning			22.00
Spraying			86.00
By Hog pasture		150.00	
By Apples and Cider		65.00	
6th year, 1908.			
Cultivating			367.00
Manure			60.00
Pruning			20.00
Spraying and material			225.00
By Hog pasture		141.00	
By 150 bbls. Apples and Cider		308.00	
Clover seed			24.00
Picking, packing and handling apples			63.00
7th year, 1909.			
Cutivating			165.00
Manure			115.00
Pruning			17.00
Spraying and material			293.00
Fertilizers			78.00
Picking, packing and handling			255.00
By Hog pasture		192.00	
By 850 bbls. Apples and Cider		1,952.00	
		$3,259.00	$4,173.00

These figures show that up to the end of the seventh year the orchard has not been self-supporting by $914.00, yet if we consider the increased value of the land, due to manure and cover crops, at $20.00 per acre the deficit is reduced to $314.00.

Some old apple trees on land purchased by Mr. Cohill several years ago have produced a full crop of apples each year for the last five years.

Another orchardist in Washington County makes the following statement from memory as he has not kept accurate records:

The trees cost $4.80 per acre and the planting $1.00 per acre. Crops were grown among the trees for the first five years and about paid the running expenses of the orchard. Ben Davis began to bear at eight years and York at twelve years of age. At the present time one half of the orchard is twenty-one years old and the other half eighteen years and the most profitable crop brought $150.00 per acre while the average income is about $90.00 per acre. The crop is good on bearing years and about one-fourth of a crop on off years. Spraying costs $15.00 per acre, pruning $1.50, picking, etc., $16.00 annually.

APPLE INSECTS AND DISEASES.

The following brief notes on insects and diseases are mostly taken from bulletins of this Experiment Station and have been approved by Prof. T. B. Symons, Entomologist, and Prof. J. B. S. Norton, Pathologist. A complete spray calendar and discussions of bordeaux mixture appear in Bulletin No. 142.

CODLING MOTH—Causes wormy apples; for complete account of this insect see Bulletin No. 142.

Remedy—Spray with arsenate of lead or Paris green as soon as petals fall from the blossoms; repeat in one week and again ten days or two weeks after the second spraying. Add the poison to bordeaux and thus spray for insects and diseases at the same time. Use two pounds of arsenate of lead or five ounces of Paris green to fifty gallons of bordeaux.

SAN JOSE SCALE—This is too destructive an insect to discuss briefly, complete directions are given in Bulletin No. 140.

PLUM CURCULIO AND APPLE CURCULIO—Cause apples to become knotty and misshapen.

Remedy—If the spraying for codling moth does not control the curculios then the trees will need to be jarred early in the morning and the insects caught on canvas spread beneath the trees.

TENT CATERPILLAR—Forms web nests in the trees in spring or fall and eats the foliage.

Remedy—Tear out the nests and destroy the caterpillars if the poison spraying for codling moth does not control them.

APPLE APHIDES—These live over winter in the egg stage on the trees.

Remedy—Fifteen per cent kerosene emulsion as soon as the eggs hatch in spring or "Rose leaf" tobacco extract one part to 40 or 50 of water.

WOOLY APHIS—Lives on roots and tops.

Remedy—Same as for other aphides on the limbs. To kill those on the roots remove three or four inches of soil for a distance of three or four feet around the tree and sprinkle on six or eight pounds of tobacco dust, throw back the earth at once.

OYSTER SHELL SCALE—These resemble miniature oyster shells on the limbs.

SCURFY SCALE—This looks like little white flakes on the trunk and limbs.

Remedy—The spraying for San Jose scale and aphides will control these scales.

BORERS—Dig out the borers with a knife or copper wire in May.

BARK BEETLE OR SHOT HOLE BORER—Small black beetle, bores minute holes in limbs and trunks.

Remedy—Cut out and burn infested parts, keep all rubbish cleaned up.

APPLE SCAB—Kills portions of leaf tissue and leaves turn yellow. Also kills little fruit stems in spring and causes black diseased spots on fruit.

Remedy—Spray with bordeaux before the buds open and again as soon as the petals fall. Ten days later spray again.

RUST—Causes thickened yellow spots on the under side of the leaves. One stage of the disease causes "cedar apples" on cedar trees and it is worse on some varieties when cedar trees are near the orchard.

Remedy—Cut out the cedar trees, spraying is not very effective.

FIRE BLIGHT—The leaves turn brown and die. It also kills blossoms and fruit spurs and causes canker spots in the bark.

Remedy—Cut out and burn the diseased twigs, cut away the cankered bark and paint the wounds with white lead and linseed oil.

CANKER—Pare away diseased bark and paint with white lead and linseed oil.

FRUIT SPOT—Commonly known as "Baldwin" spot. Causes dark colored spongy spots beneath the skin.

Remedy—Same as for apple scab.

BITTER ROT—Appears on the fruit as brown decayed spots with concentric rings.

Remedy—About June 15 use bordeaux and make four or five more applications at intervals of two weeks.

BLACK ROT—Causes darker spots than bitter rot does. As rot increases, scattered black dots appear and decayed part turns black and dries up.

Remedy—Same as for apple scab.

CROWN GALL—Appears as knotty swellings on the crown or union of root and top and on the roots. Root grafted trees seem to develop it badly in the nursery. Very often thick tufts of fibrous roots known as "hairy root" are associated with it.

Remedy—Burn every tree that shows any indications of galls or thick tufts of roots.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 145. JUNE, 1910.

TUBERCULOSIS OF ANIMALS.

By S. S. Buckley.

Introductory.

The vast amount of literature which exists upon the disease, Tuberculosis, precludes all possibility of summarizing the theories advanced and investigations pursued in its history, within the compass of a brief report.

The purpose of this bulletin is to record the experiences of the writer, with some phases of the disease, tuberculosis, as he has encountered it during the past thirteen years in Maryland; and to present some recommendations for systematic suppressive measures in an effort to reduce this most serious menace to the Dairy Industry and the Public Health.

Maryland has been doing a great work in the advancement of knowledge concerning tuberculosis in man. She has been among the first to protect her citizens from tuberculosis dissemination, by enforcing sanitary laws and has liberally endowed institutions for the treatment and care of tuberculosis patients. She has contributed liberally in an effort to educate the public for their protection against infection and in providing comfortable sanitary surroundings for advanced cases of the disease.

The State and private individuals have accomplished a great deal through a system of cooperation in establishing homes for incurable cases of the disease. Maryland, however, has not given the attention to Tuberculosis in Animals, which its importance demands as a factor in the transmission of the disease among animals and man.

In examining the laws and legislative appropriations for Tuberculosis control in Maryland it is observed that but one law is directed at tuberculosis suppression in animals, and that one aims at the exclusion of diseased cattle from other States, without in any measure affording relief to conditions already existing within her borders.

Statistical information regarding the extent of tuberculosis in the State is not very reliable, but such as we have indicates in a general way that, 2500 citizens of Maryland die from tuberculosis every year, and that 10,000 citizens of Maryland are affected with tuberculosis. The population of Maryland is about 1,250,000, of which half reside in Baltimore City and the other half in the smaller towns and country districts.

Half of the tubercular deaths and half of the tubercular cases

occur in Baltimore City, and the remainder in the State, exclusive of Baltimore.

It is observed, therefore, that the smaller towns and country districts have a large share of tubercular infection, and the idea that Tuberculosis is chiefly a disease of large cities is a mistaken one.

There are over 300,000 neat cattle in Maryland of which not less than 150,000 are dairy animals.

There is consumed annually in Maryland more than

20,000,000 gallons of milk,
9,000,000 lbs. of butter,
135,000 gallons of cream,
300,000 lbs. of cottage cheese.

Reliable statistics of the extent of tuberculosis in the DAIRY cows of Maryland are not available, but to estimate it at 15 per cent. is undoubtedly low. That places the number of tuberculous dairy animals at not less than 22,500.

Owing to the practice of mixing the milk of all cows of a herd is it unreasonable to suppose that at least one-fourth of the milk, cream, butter and cottage cheese consumed comes in part from these animals? That would mean that

5,000,000 gallons of milk,
2,250,000 lbs. of butter,
33,750 gallon of cream,
75,000 lbs. of cottage cheese

consumed in Maryland anuually, is in constant danger of infection with the organism of Bovine Tuberculosis.

It is probably a fact that from *five per cent. to ten per cent. of all cases of Human Tuberculosis* is due to the Bovine Tubercle Bacillus.

In view of the positive intertransmissability of the germ, is this in the least surprising?

These statements are made, not for the purpose of suggesting revolting conditions to the consumers of such products, but to direct attention to existing and growing evils which demand consideration, if we desire their correction.

We have it our power to safeguard the health of the consumer of such food, by cooking the flesh of such animals as are used for food and pasteurizing the dairy products. Such practices, however, do not mitigate the real evil, in that they deal with the effect and not the cause.

The sources of such infected products remain as centers for the dissemination of disease to all susceptible creatures, and no systematic effort is being made by the State to hold it in check or to prevent its increase.

The tribute in lives and money levied upon the people of Maryland by this disease is a far greater tax than that necessary for all State expenditures.

Sporadic efforts for the control of Tuberculosis by the State or by individuals will avail little and tend to discourage and delay proper measures of suppression.

It is not a disease for dairymen and stockmen alone to combat, for physicians and veterinarians to eradicate, nor for the legislature to suppress with laws. It is a foe which needs the skill, vigilance and patient efforts of all our citizens, acting in harmony and working faithfully, without intermission, until control is secured.

CAUSE.

The cause of Tuberculosis was first definitely stated in the reports to the physiological Society of Berlin in 1882 by Prof. Robert Koch.

In this contribution, experimental evidence was presented which established beyond any possibility of doubt the presence in all tuberculosis infected individuals, of a microscopic rod-shaped parasite, to which the name "Bacillus Tuberculosis" was given. These organisms were further demonstrated to be present in all stages of the disease. When introduced in suitable amounts into healthy susceptible animals, tuberculosis developed. The extensive and careful work done by Koch, and the conclusions drawn, were so convincing and so exact that no substantial modifications have been made necessary in subsequent years in the technic of tuberculosis study.

There is no longer any question as to the causative agent of this disease, nor any contention regarding its disease producing powers.

There is, however, even at the present time, a diversity of opinions, as to whether the organism of tuberculosis, in the different species of animal life, is in all respects identical.

The importance of absolute proof of this point is interesting, but not vital to the problem of tuberculosis control.

The bacillus tuberculosis does not propagate itself outside of the animal body, except when suitable artificial conditions are afforded, as in the laboratories. So far as known, such conditions do not exist in nature, in soil, air, water or living vegetable matter, and cultivation and experimentation with this organism necessitates proper laboratory facilities and susceptible animals. Even when these are employed, difficulties are sometimes experienced in securing the first, artificially propagated generation. Each succeeding generation becomes more and more easily cultivated artificially, as the bacillus becomes adapted to its changed environment.

While this adaptation to surroundings is becoming established, however, the power of inducing tubercular infection in animals is lessened, and its parasitic nature more or less completely destroyed.

Upon this fact is based the hope for successful immunization of animals against tuberculosis. SINCE DIFFICULTY IS EXPERIENCED IN PROPAGATING CULTURES UNDER CHANGED ENVIRONMENTS, THERE IS OFFERED AN OPPORTUNITY FOR THE STUDY OF ITS TRANSMISSION TO ANIMALS, WHERE *THEY* ARE MAINTAINED UNDER CHANGED CONDITIONS. Such influences will be considered under the head of susceptibility and predisposition. (P. 278).

SYMPTOMS.

The symptoms of tuberculosis in cattle may range from the persistent presence of the organism in the excretions, without other appreciable signs, to most aggravated symptoms characterizing generalized advanced tuberculosis.

Primary acute or "quick" tuberculosis, rapidly terminating in death, is rare in animals, while the chronic, slowly progressive form is unfortunately common and lasts for months or years. Either type represents a centre for the spread of the disease to all susceptible animals with which it is in constant contact.

The symptoms of tuberculosis are variable and are dependent upon the localization, the amount or dosage, the virulence of the infecting organisms and the natural resistance which the victim of the infection possesses. Localization of the infection, however, more greatly influences the nature of the symptoms while the severity of such, relates to the virulence and dosage.

No body organ or tissue seems to be immune to infection with the tubercle bacillus, though certain tissues are more susceptible than others.

1. Lymphatic Glands:—

Tuberculosis can be detected in the lymphatic glands when it appears to be absent in the other body tissues. This is due to the transportation of the bacilli from a part of the body by the lymph vessels which drain that part and the marked susceptibility of the glands to infection. When the disease is apparent in any organ, the associated lymph glands are always more or less involved.

This fact renders the detection of tuberculosis on post mortem comparatively simple.

2. Lungs:—

A commonly mistaken opinion is held by the public that the lungs are the only seat of this disease, and unless cows breathe very irregularly or cough incessantly that tuberculosis cannot possibly be present. The lungs are commonly the seat of extensive deposits of tuberculosis tissue, and physical examination will reveal such condition, as indicated under diagnosis, but failure to so detect it does not establish positively the absence of tuberculosis in that individual.

3. Pleura:—

The pleura is a thin, serous membrane, lining the chest walls and covering the lungs externally. Inflammation of this membrane constitutes pleurisy, and when the inflammation is caused by or associated with the Tubercle Bacillus we have a condition of Tubercular Pleurisy. This condition is rarely found alone in cows, but usually associated

with tuberculosis of the lungs. It may be detected on physical examination, and readily upon post mortem inspection.

4. Liver:—

The liver is usually not extensively diseased in tuberculosis, but frequently shows tubercular nodules beneath its capsule, in the substance of the liver itself or in the associated lymph glands.

5. Udder:—

The udder may be the seat of extensive tubercular disease. When existing it may be mistaken for the remains of an antecedent Mastitis or Garget, and probably does frequently bear intimate relation to such a condition. The mammary lymphatic glands may be involved and offer a hardened, enlarged condition which aids in diagnosis. It is a safe practice to reject for milk purposes any cow having a nodular mass or masses within the secreting udder, as regardless of the presence or absence of tuberculosis the milk is more or less abnormal in character. ACUTE UDDER TUBERCULOSIS MAY BE PRESENT WITHOUT APPRECIABLE EXTERNAL SYMPTOMS.

6. Heart:—

The serous sac surrounding the heart occasionally becomes the seat of extensive tubercular deposits and is associated with generalized tuberculosis. As a primary infection it is doubtful if it ever exists.

7. Bones:—

Tuberculosis of the bones may exist, though it appears to be more rare than in former years, probably on account of greater knowledge about the disease, and the destruction of generalized cases early.

DIAGNOSIS.

Ability to correctly diagnose tuberculosis is of fundamental importance in any measure directed at its suppression. Without, at this point, entering into any discussion as to the proper disposal of infected individuals, it must be emphasized that the existence and location of *all* cases of tuberculosis, and the location of *all* infected premises is a first requisite in any suppressive measure in a community.

There are three principal ways of determining the existence of tuberculosis on a premises.

1. Physical Examination.

By physical examination of animals is meant the direct examination of all susceptible animals, for such combination of symptoms as

would positively indicate tuberculosis. There are many writers of veterinary literature who place great stress upon ability to diagnose tuberculosis from physical examination alone. This ability is worthy of the highest regard, yet such alone will never go far in eradicating tuberculosis from a community. THE REASON FOR THIS LIES IN THE FACT THAT TUBERCULOSIS EXISTS FROM THE VERY MOMENT THE BACILLI BECOME LODGED IN ANY TISSUE OF THE ANIMAL BODY AND BEGIN TO PROPAGATE THERE.

Neither physical signs nor symptoms are possible of detection at this stage, and such animal may become a menace to all other susceptible animals in close proximity, due to the elimination of tubercular germs in the body excretions. However, there are symptoms which lead one to suspect the existence of tuberculosis when present in a more or less advanced stage, and when localized in a part of the body which admits of certain methods of examination.

In pulmonary tuberculosis for example there may be present a characteristic cough, though not usually a paroxysm of coughing as is generally supposed. The character of the cough is dependent upon the extent of disease. The tubercular cough is provoked by excitement, by exercise, by going into the cold air from a warm stable,—in short, by any act which makes a deep inspiration of air necessary.

A tubercular lung may be filled with air without difficulty, but its retention is impossible, and almost invariably it is quickly expelled with an explosive effort or tubercular cough. ADVANCED TUBERCULAR CASES AT REST, MAY COUGH BUT VERY LITTLE IN SPITE OF EXTENSIVE DISEASE OF THE LUNGS.

Unless affected to an advanced degree, the respirations are not greatly altered in character. The detection by means of auscultation and percussion is not possible to nearly the same degree, as in the human chest, because of anatomical differences. They are valuable adjuncts, however, to a general physical examination. The temperature variation too, cannot be regarded so highly as a symptom, as in the human because of the normal limits of variation, in perfect health.

When the disease is advanced there is possibly emaciation, a dull lustreless condition of the hair, a dry and inelastic skin.

When intestinal tuberculosis exists there are in addition to the above symptoms, periodic attacks of digestive disorders, such as bloating, constipation and diarrhoea, together with a finical appetite.

When genital tuberculosis exists there may be an abortion, followed by failure to breed and almost continuous periods of heat. Abortions, however, are frequently symptomatic of tuberculosis, even when the genitals are apparently free of the disease, due probably to inability to properly nourish the foetus. The superficial lymphatic glands of the throat, udder, elbow and flank may be enlarged, but otherwise do not offer any positive indications of the disease.

IN GENERAL IT MAY BE STATED THAT A COMBINATION OF A NUMBER OF THE SYMPTOMS ENUMERATED.

WOULD JUSTIFY ONE IN DECLARING THE EXISTENCE OF TUBERCULOSIS, AND AN INVESTIGATION OF ITS EXTENT UPON THE PREMISES SHOULD BE STARTED.

Before describing a second method for determining the existence of tuberculosis it is advisable to note there are those who, through ignorance, indifference or for mercenary motives advocate the removal from a herd and premises, of those animals, only, in which the existence of tuberculosis can be detected by a physical examination.

Such persons, by the way, almost invariably advocate a policy of liberal indemnities to be paid by the State.

Any such practice would insure its perpetual existence upon a premises, so infected, so long as susceptible animals were kept there, exposed to and in contact with those with slight infection, unless some system be followed as described under Prevention and Immunization. (P. 281).

2. Post Mortem Examination.

Frequently the first thing, to direct an owner's attention to the possibility of tuberculosis in his animals, is the presence of positive evidence through post mortem examination of one of them.

WHEN A POST MORTEM EXAMINATION REVEALS TUBERCULOSIS IT IS ABSOLUTE PROOF OF AN INFECTED PREMISES, AND THE EXTENT OF THE INFECTION SHOULD BE SPEEDILY DETERMINED.

When animals have been removed from a premises and slaughtered, their identity and source is frequently lost sight of. There exists in the matter of post mortem examinations, a most valuable aid in the location of tuberculosis infected premises.

Dr. Burton Rogers, of the U. S. Bureau of Animal Industry, has given considerable attention to the value of post mortem results in locating infected farms. He has suggested a unique system for tagging animals, so that their identity and source is not lost sight of. In communities where tuberculosis infection is not general, his system should be extremely valuable. His observations were based largely upon the ability to locate tuberculous dairies through the examination of carcasses of milk fed hogs. In the practice of post mortem examinations with a proper system of identification, an inspector would do a double duty in judging the fitness of a carcass for food and in locating tuberculosis infection on a premises.

While post mortem evidence is positive, it is so, only with respect to the case examined, and the existence of further infection must be determined by other means. It should be emphasized that post mor-

Note—(Every animal dying upon a farm from any cause should be carefully and completely examined by the person in charge of the animals, for its educational values. Such a practice will, in time, enable him to detect diseased conditions in living animals, and be of the greatest service).

tem examination discloses its evidence to other species than its own, so that diseased hogs may locate a diseased dairy herd.

3. Subcutaneous Tuberculin Testing.

The name tuberculin is nearly as familiar to the stockman as the name tuberculosis. As introductory to the discussion of tuberculin testing I cannot refrain from quoting a paragraph from Prof. James Law's bulletin on tuberculosis. He says, "MUCH HAS BEEN SAID AND WRITTEN AGAINST THE TUBERCULIN TEST BY THOSE WHO HAVE NEVER USED IT, AND WHO ARE THEREFORE UTTERLY INCOMPETENT EITHER TO ENDORSE OR CONDEMN IT, BUT FOR THOSE WHO AIM AT THE PROMPT AND THOROUGH ERADICATION OF THE INFECTION FROM A HERD, AND AT THE SECURING AT ONCE OF A GUARANTEE OF PROGENY, BEEF AND DAIRY PRODUCTS, NO RESORT CAN, AS REGARDS ITS EFFICACY, BE AT ALL COMPARED WITH THE TUBERCULIN TEST."

Usually the discovery of an agent, which, when properly used by competent persons, enables them to detect positively the existence of a condition that is not revealed by any other means, is hailed as a wonderful triumph. If the opposition to the use of tuberculin as a diagnostic agent came from those, only, who were ignorant of its properties and who could not inform themselves of its virtues, it would be wholly excusable.

The practice of using tuberculin, however, has been and is now, condemned by some who know its value and who have been in a position to observe its reliability.

There are two reasons why such an attitude is assumed against tuberculin testing.

1. Because tuberculin is too critical, because it exposes a state of affairs with which no other known method of diagnosis can compare for exactness.

2. Because tuberculin has been most shamefully misused by indifferent, incompetent and unscrupulous persons, and has been brought into some disrepute by them. The exaggerated and inaccurate statements against the practice of tuberculin testing will be disregarded for the reasons given above; however, attention is directed to the following:

Tuberculin prepared by responsible manufacturers, and properly used, (a) will not produce tuberculosis in healthy animals; (b) it will have no permanent effect upon the quantity of milk produced; (c) it will not produce abortions, unless there should be extremely advanced tuberculosis, and it then is a remote possibility.

When improperly used tuberculin may be responsible for a variety of results and its efficiency as a diagnostic agent brought into disrepute.

Tuberculin, when diluted for use, is the preserved sterile, filtered product of the growth of the Tubercle Baccillus under artificial or laboratory conditions, for a proper time upon a glycerinated beef broth culture media. The fact of its being sterilized and filtered. precludes any possibility of its transmitting tuberculosis to an animal into which it is injected.

THE APPLICATION OF TUBERCULIN.

The Selection of Animals:—

Animals should not be subjected to a tuberculin test.

1. When suffering from any condition accompanied by fever.
2. When three weeks' prior, or subsequent to calving.
3. When undergoing the period of "heat."
4. When atmospheric temperatures are extreme.

Proper consideration should be given to the tests of animals subjected to unusual variations in their habits, such as stabling cattle accustomed to run at large, or shipping by rail or boat, and nervous as a result.

Throughout a test animals should not be subjected to unnecessary excitement, and as far as practicable should be treated in the manner to which they are daily accustomed.

When the herd has been stabled, and the selection of those to be tested made, the number, name or other designation of the animal should be arranged upon a suitable chart, in regular order, from one end of the stable to the other. The next step is the preparation for taking the temperatures.

Temperatures:—

There should be accurate clinical thermometers provided, with a bulb or loop at one end, to which can be secured a piece of thin tape. Another form has the top of the thermometer cemented into a metal cap, to which is fastened a piece of light chain bearing a clip to fasten to the base of the tail.

A suitable pan or basin of disinfecting fluid and towels complete the equipment for the work of taking preliminary temperatures.

Pre-injection Temperatures:—

The temperatures must be taken at intervals of two hours, beginning twelve hours before the time selected for making the injection of tuberculin. The thermometer must be wholly inserted into the rectum or vagina and remain there fully three minutes. It is then wiped off, read, the temperature recorded, the mercury shaken down and the thermometer placed in the disinfectant completely. The temperatures of the other animals are then secured. It is desirable to

use individual thermometers, especially where vaginal temperatures are taken, and to have several exposed at a time, to facilitate the work.

After securing these preliminary temperatures an examination must be made of the chart and any animal rejected from the test, whose temperature at any period has exceeded 103 degrees F. This is done in order to avoid errors in the interpretation of results of the test.

THE ANIMALS ARE NOW READY FOR THE ACTUAL TEST, AND UNDER NO CIRCUMSTANCES SHOULD TUBERCULIN BE ADMINISTERED WITHOUT THIS SELECTIVE, PRELIMINARY WORK OR THE RESULTS MAY BE OPEN TO A QUESTION OF ACCURACY.

Tuberculin Injection:—

The site for injection, conveniently the side of the neck, is clipped or sheared of its hair for a space of four inches square, washed with disinfecting fluid, and dried with cheese-cloth or a towel.

The syringe, which has been cleaned, and found in perfect working order, is filled with the proper dose of tuberculin. The needle clean, bright and sharp, is inserted through and well under the prepared skin into the subcutaneous connective tissue.

The syringe, containing its dose of tuberculin, is now attached to the needle and the plunger carefully pressed until the full dose is emptied. The syringe and needle are then removed and cleaned. The seat of injection is lightly massaged to diffuse the tuberculin in the tissues, and cause its rapid and general distribution throughout the system.

Post-injection Temperatures:—

Beginning six hours after the administration of tuberculin the work of taking temperatures at two hour intervals is resumed and conducted in all respects like that preceding the injection of tuberculin. The temperatures should be taken until twenty hours after the injection, and in exceptional cases it is necessary to secure them for a longer period.

Interpretation of Results:—

It is here that experience is valuable to the one conducting a test. Animals whose temperatures remain below 103 degrees F. are to be considered "non-tubercular," those whose temperatures exceed 103 degrees F. and do not go beyond 104 degrees F. are to be regarded as "suspects;" while those whose elevation of temperature is above 104 degrees F. are to be regarded as "reactors" and are therefore to be pronounced "Tuberculous."

The accompanying charts illustrate a "non-tubercular," a "suspicious" and a "reacting tubercular animal."

Name or Number of Animal.	Temperatures Before Injection.						Tuberculin Injection.	Temperatures After Injection.												Maximum.	Conclusion.
	Hours Before Injection.							Hours After Injection.													
	12	10	8	6	4	2	Am't	2	4	6	8	10	12	14	16	18	20	22	24		
133	101.8	101.4	101.6	101.6	101.6	101.6	2 c. c.	.....	.....	102.0	101.8	102.0	101.6	101.0	101.0	101.4	101.6	101.6	.....	102.0	Healthy
113	102.0	101.0	101.2	101.2	101.2	101.4	2 c. c.	.....	.....	102.0	101.8	102.2	101.4	101.0	101.2	101.2	101.4	101.4	.....	102.2	"
141	102.0	101.2	101.2	101.4	101.6	101.8	2 c. c.	.....	.....	102.0	102.0	102.4	101.6	101.0	101.0	101.2	101.4	102.0	.....	102.0	"
102	102.2	102.0	102.0	102.0	102.2	102.2	2 c. c.	102.2	103.0	103.6	103.8	103.6	103.4	100.2	101.6	102.6	102.2	102.2	.....	103.8	Suspicious
G. C. S.	102.4	102.4	102.2	102.2	101.8	101.8	2 c. c.	101.8	102.0	102.6	103.2	103.0	102.0	102.0	101.6	101.6	101.2	101.4	.....	103.2	"
85	101.0	101.0	101.4	101.4	101.8	102.6	2 c. c.	.....	.....	102.0	103.4	102.2	102.2	102.0	101.2	101.2	101.8	101.8	.....	103.4	"
119	102.0	102.6	101.8	101.6	101.6	101.8	2 c. c.	101.8	102.2	103.4	104.4	106.0	107.2	108.0	107.2	106.0	103.0	103.0	.....	108.0	D'seased
120	101.4	101.8	100.0	101.4	101.4	101.4	2 c. c.	101.8	102.2	103.2	104.0	104.6	105.0	104.8	104.4	102.8	101.8	101.8	.....	105.0	"
121	101.8	102.6	100.2	101.0	101.8	102.2	2 c. c.	102.2	103.0	103.8	105.0	106.2	106.6	106.4	106.6	103.8	102.4	102.4	.....	106.6	"

Occasionally, however, there are irregular temperature variations which are troublesome to classify, but these are not common. Some such irregularities are found in clinically visible cases,—active advanced cases,—where reactions may not occur. Sometimes there are irregular spurts of high temperatures for which there seems to be nothing responsible. Abnormal susceptibility or idiosyncrasy of an individual may be responsible for some of these freak reactions, but this is a dangerous admission, and one that should not be indulged too greatly. It is probably safer to admit that occasionally there are irregularities in temperatures which cannot be accounted for, and such animals should be subjected to vigorous physical examination and a subsequent tuberculin test before a final conclusion is reached.

THE RESULTS OF A TEST CONDUCTED AND INTERPRETED AFTER THE MANNER ABOVE DESCRIBED CAN SAFELY BE REGARDED AS MORE ACCURATE THAN THOSE FROM ANY OTHER ONE SYSTEM OF DIAGNOSIS, AND COMBINED WITH PHYSICAL EXAMINATION IS ESSENTIAL IN ANY SUPPRESSIVE MEASURE FOR TUBERCULOSIS CONTROL. Tuberculin, however, does not produce a reaction during the stage of incubation, or development stage.

SUSCEPTIBILITY AND PREDISPOSITION.

While the cause of this disease is primarily the Tuberculosis Bacterium there must be reckoned with the natural susceptibility of the species and of the individual and the influences operating for or against the facilities for infection. Among our domesticated animals, cattle and hogs are more prone to infection than other species.

Formerly there was held the opinion that certain breeds of cattle and hogs were much more susceptible to tuberculosis than other breeds. Now, however, this distinction has been superseded by the rating of susceptibility upon the stamina of families and breeding, and not upon breeds.

In conjunction with this, and of no less importance, is the housing and management of animals, regarded apart entirely from opportunities for infection. That is to say, the remote effects of stabling animals (excepting only in corrals or covered paddocks) due to the impossibility of perfect ventilation; the unnatural character and quantity of foods, forced early maturity and prolonged lactation periods all militate against the resistance of individuals to infection, and in proportion to the number of generations of animals so housed and managed, do we find the susceptibility to infection, when exposed, increased.

The fact, therefore, that susceptibility is affected by such practices offers an invaluable asset to any measure of suppression of tuberculosis which may be used through the cultivation of individual powers of resistance of our animals.

There must be a retreat or falling back to a certain extent from

the point where feeding, breeding and stabling practices have carried us, in order to rectify the damage done to the constitutional vigor of animals.

It is a most deplorable misfortune that health, bodily vigor and endurance had not its proper weight in the score of animals for points of excellence, during the years in which so much has been done for conformation and production.

Cattle which cannot endure the cold of winter, and the heat of summer; those which must be protected from the rains in moderate temperatures; those which cannot lie upon the ground or floor without serious disturbances offer ample evidence that constitutional vigor is wanting.

It is the hardy, vigorous animal to which we must look for immediate relief in breeding, even though points are sacrificed on the score card or pounds are wanting at the pail for records, if we regain the natural resistance which is innate in animal life in nature.

DISSEMINATION.

In the early history of tuberculosis it was the accepted theory that heredity was the important factor in the dissemination of tuberculosis. Later the idea of direct transmission of the disease was abandoned, but while heredity can play no part it must be remembered that congenital tuberculosis is possible and might even cause a serious result in the spread of the disease if it were entirely lost sight of. Under the Bang system, for instance, to be referred to later, such transmission might work havoc among an otherwise well protected herd.

Direct transmission through coition is possible and for that reason the alternate use of a sire on healthy and diseased cows is unsafe.

Air.

The air has long been held to be the chief medium through which the Bacterium Tuberculosis is transmitted from one individual to another. The fact that the throat, lungs, and pleura with their associated lymphatic glands are more commonly affected, apparently tends to confirm this. Except experimentally, such transmission is not possible alone, as infection through the digestive tract may occur as readily from the air as through the respiratory tract. Since the air may convey disease germs to the respiratory and digestive systems both, it demands careful consideration.

Food and Drink.

The opportunities for infection through food and drink greatly overshadow all others and in a way offer conditions difficult to control.

Expired air from the lungs of actively tubercular cases, milk and particularly faeces from such animals may infect the floors, walls and

furnishings of stables and readily contaminate the food and water.

Stable yards and pastures receive like deposits but the danger here is not so great owing to the destructive action of light and air upon the infecting organism.

COURSE AND DURATION.

Tuberculosis of cattle is of slower development than tuberculosis of man. Its course and duration like the symptoms is necessarily dependent (1) upon the virulence of the infecting organism; (2) upon the individual powers of resistance of the infected animal; (3) upon conditions of care and management; (4) and finally upon the localization of the infection.

Acute rapid tuberculosis with fatal termination is extremely rare, while slow progressive infection is to be found wherever an aggregation of dairy cattle exists throughout the civilized world.

TREATMENT.

Inasmuch as the term cure when used in connection with tuberculosis, is a relative term and signifies merely the arrest of progress and not obliteration and cessation of disease, we must consider the economic importance of treatment.

Cured tuberculosis,—arrested tuberculosis,— refers to a condition in which progress and spread of the infection in an individual has been checked, possibly even to the extent that nature has "walled off" the diseased from the healthy tissues with a capsule that may never permit the escape of the contained bacilli. There is always a possibility, however, that this barrier may become destroyed and the organism liberated for more extensive infection.

In treatment for human tuberculosis, the aim is to relieve suffering, prolong life, and, when possible, restore health to an extent where the usual or other vocation can be followed. With animal tuberculosis, however, restoration to such degree of health as will make their keep profitable is the sole object. Animals are profitable for their slaughtered value, their dairy value or their breeding value.

SLAUGHTERED VALUE.

Any animal which is so seriously infected as to be rejected immediately at slaughter for human food, would probably not have been considered wholesome when it had gone through with a successful course of treatment. The expense of maintaining such an animal together with the cost of treatment would be prohibitive for such purpose and treatment with the object of subsequent slaughter is out of the question as an economic matter.

DAIRY VALUE.

The treatment for tuberculosis would, of necessity, demand the "drying up" of the milk secretion, to prevent the drain upon her system. The dairy value would then be negative, and the same elements of expense would eliminate profitable retention in the herd of such cases.

BREEDING VALUE.

For breeding purposes alone, then, can there be any justification for the retention and treatment of cattle after tuberculosis has been diagnosed. When tuberculous cattle are maintained for the value of their offspring no better plan has been advocated than that known as the "Bang System" for breeding a healthy herd from a tuberculous herd. This method will be discussed under the head of Prevention.

Treatment, then, in the present state of knowledge upon tuberculosis is not profitable in cattle and the retention of diseased animals for purposes of treatment continues the existence of infected centers from which there is danger of transmission to healthy animals and is a hazardous measure.

PREVENTION AND IMMUNITY.

Suppression of tuberculosis is possible, only through measures for prevention and lessened susceptibility. With the extreme susceptibility which cattle possess, the wide prevalence of the disease and the additional expense involved, it is improbable that any considerable success can be had from the system of segregation of slightly infected animals and the rearing of their offspring alone. Such is virtually the Bang system, described elsewhere. If, however, there is combined with this the practice of artificial immunization and a strengthened natural resistance through proper rearing of the young and through modifications of the present system of care and management of cattle there is reason to expect speedy relief from the present situation at comparatively moderate cost.

The Bang Method.

This consists in utilizing all reactors or tuberculous cattle found by the tuberculin test, which have no physical evidence of disease, for the rearing of calves. These calves are removed from their dams at birth, and fed upon milk from healthy cows or upon pasteurized milk. All cows kept for this purpose are maintained under strict quarantine measures, and are removed and slaughtered if physical symptoms develop. All non-reacting cows are subjected to periodic tuberculin tests and all reacting animals, without physical evidence of disease, are placed in the quarantined herd. All calves so raised are bred

and placed in the healthy herd if they do not respond to the tuberculin test.

When the herd has been restored to its original size by this means the quarantined herd can be fattened and slaughtered under proper supervision, and the disease thereby eradicated.

The advantage of the method is that the reacting, but slightly infected, cattle assist in the restoration of the herd, and are self-supporting during such period of time as may be necessary to build up a healthy herd.

METHODS FOR DIMINISHING SUSCEPTIBILITY.

Two principal methods for increasing the resistance to tuberculosis infection will be considered. 1st. Artificially Produced Immunity. 2nd, Naturally Produced Immunity.

ARTIFICIALLY PRODUCED IMMUNITY.

The development of a method for increased resistance to infection for any disease must necessarily be slow, as its success, its safety and its practicability must be assured. One of the earliest and most notable instances of artificially produced immunity was secured by Jenner in his work with Smallpox. Koch had in mind the idea of immunization when he produced the "lymph," now known as tuberculin. From that time to the present, investigations have been conducted to perfect a process of immunization against tuberculosis.

Trudeau and de Schweinitz first attempted the protection of animals against infection by a vaccination process. Later Theobald Smith described variations in the bacilli of tuberculosis according to their origin, and directed attention to the low virulence for cattle of human bacilli.

This knowledge made the opportunity for applying the principles of Smallpox vaccination, i. e., the use of organisms of low virulence for the protection of the individual against organisms of greater virulence.

In this work many investigators have been engaged, notably among whom were Pearson and Gilliland in this country and McFadyean, Koch and von Behring abroad.

Pearson and Gilliland (1902) were first to report the successful immunization of animals by the use of tubercle bacilli of the human type.

Von Behring (1902) was the first to announce a practical method for bovine immunization. His method with subsequent modifications has been in use continuously since then.

Von Behring's Method—Bovovaccination.

Our experience here with Bovovaccine began in the spring of 1905. In addition to the question of successful immunization it was important to observe the effect upon the treated animal and the ease of applying the treatment.

A method to be of value must be capable of easy administration under conditions surrounding the animals as ordinarily kept.

The directions for administering the vaccine as prepared at that time are as follows:

Animals Which May Receive the Treatment.

"As a rule, only apparently healthy animals at the age of from two weeks to three months (for the first inoculation) are chosen."

Marking the Animals.

"Each animal should be marked with a number .... As soon as the first mark becomes indistinct, it is advisable to repeat the same."

Dosage of the Bovovaccine.

"For the first inoculation, one immunizing unit is used for each animal; for the second inoculation, which should be made not sooner than 12 weeks after the first, five immunizing units are used for each calf."

Preparing Bovovaccine for Injection.

"For the injection the Bovovaccine is uniformly mixed with a freshly boiled and cooled one per cent salt solution."

Making the Injection.

The injection of a quantity of the freshly prepared emulsion, which contains one immunizing unit of the Bovovaccine is injected into the jugular vein in the same manner as in any other intravenous injection.

For the second treatment a dosage of five immunizing units is recommended.

Ease of Administration.

Our experience with the preparation of the emulsion and its injection into the jugular vein of the young calf, proved that there was

no part of the work difficult or especially tedious, but that in some stables it was inconvenient to satisfactorily prepare the emulsion on account of the arrangement of the stable, and therefore not so desirable as the present form in which it is received. Any person qualified to make an intravenous injection can readily administer Bovovaccine.

Present Form of Bovovaccine.

Recognizing the many inconveniences of preparing emulsions at stables, and finding that emulsions retain their qualities for a suitable length of time, the producers of Bovovaccine are now dispensing the virus in an already emulsified form.

This at the same time should allay the fears of those who regard the preparation of the emulsion as dangerous to the operator.

Test I.

In a test to determine the effect of Bovovaccination upon young calves and the extent of immunity it conferred, two calves were selected for treatment, and later two calves were gotten to serve as controls in an infection exposure.

Calf V. 3.—Dropped Mar. 10, '05
1st Vaccination April 13, '05
2nd Vaccination July 17, '05

Calf V. 5.—Dropped Mar. 19,' 05
1st Vaccination April 10, '05
2nd Vaccination July 17, '05

Temperatures following 1st Injection.

	9 a. m.	12 n.	5 p. m.
Calf V. 3.			
April 14	102.6	102.6	103.0
April 15	102.6	102.4	102.8
Calf V. 5.			
April 11	102.6	103.0	103.2
April 12	102.6	102.8	103.0

Temperatures following 2nd Injection.

	9 a. m.	5 p. m.
Calf V. 3.		
July 19	102.4	102.2
July 20	102.0	102.2
July 21	102.4	102.2
July 22	102.0	102.0
Calf V. 5.		
July 19	102.0	102.2
July 20	102.2	102.2
July 21	102.2	102.4
July 22	102.4	102.6

Weights taken Monthly.

	Calf V. 3.	Calf V. 5.		Calf V. 3.	Calf V. 5.
April	70	80	Sept.	203	222
May	89	104	Oct.	210	219
June	105	129	Nov.	234	247
July	141	157	Dec.	213	228
August	...	...	Jan. 6	210	242

Reference to the table of weights and temperatures, therefore, indicates that no marked reaction followed in these cases.

Exposure to Infection.

Control Calf 9, dropped August 20, 1905, and Control Calf 10, dropped June 29, 1905, were selected as check animals in an infection test. Both were normal and had made good growth.

Control Calf 9, was tuberculin tested, without reaction, on November 20 and 21. Control Calf 10 was not tested.

Calf V. 3. was not tuberculin tested while Calf V. 5. was tested November 20 and 21 without reaction.

Calf V. 3. and Control Calf 9 were given intravenously one centigram of a virulent culture of bovine tubercle bacilli obtained from the U. S. Bureau of Animal Industry. This was a gelatin culture from which one centigram of the surface growth was scraped and mixed with sterile salt solution. The injection was made November 24, 1905.

Temperatures following Injection.

	8 a. m.	1 p. m.	5. p. m.
Nov. 25—Calf V. 3	103.0	103.0	102.8
Control Calf 9	104.0	103.4	104.0
Nov. 26—Calf V. 3	102.8	101.8	102.2
Control Calf 9	104.0	102.6	103.4
Nov. 27—Calf V. 3	102.4	.....	103.0
Control Calf 9	103.6	.....	102.8
Nov. 28—Calf V. 3	103.0	102.4	102.0
Control Calf 9	103.8	103.6	103.6
Nov. 29—Calf V. 3	103.8	103.6	103.4
Control Calf 9	104.2	103.8	104.0

Calf V. 5 and Control Calf 10 were given intravenously 2 centigrams of the virulent culture prepared like the above on November 24, 1905.

Temperatures following Injection.

	8 a. m.	1 p. m.	5 p. m.
Nov. 25—Calf V. 5	103.0	103.0	103.0
Control Calf 10	104.0	104.0	103.8
Nov. 26—Calf V. 5	102.8	102.8	102.6
Control Calf 10	103.4	102.6	103.0
Nov. 27—Calf V. 5	102.4	.....	102.4
Control Calf 10	103.0	.....	103.2
Nov. 28—Calf V. 5	102.6	102.4	102.4
Control Calf 10	103.2	102.8	103.0
Nov. 29—Calf V. 5	103.0	103.0	103.2
Control Calf 10	103.6	103.4	103.2

On December 26, 1905, Control Calf 10 began to show marked symptoms of distress. The appetite was lost and diarrhoea was present. From day to day weakness and depression were extreme. There was a weak but distressing cough. Respirations rapid. The condition of the bowels variable. On the night of January 3, 1906, she died. Weight of carcass 114 lbs. On January 4 a post mortem examination showed a nodule about 5 mm in diameter in the left submaxillary lymph gland. The right gland normal. The retropharyngeal, prepectoral, prescapular and brachial glands were normal. The bronchial glands enlarged. The posterior mediastinal glands were greatly enlarged. The lungs completely infected with miliary tubercles. The parietal pleura was involved on both sides of the thorax. Considerable thoracic fluid present. January 6, 1906, the other calves were killed and examined. Control Calf 9 showed miliary tubercles on the surface of both lungs, with about twenty deposits appearing quite prominently. No nodules were found in the glands. Weight 105 lbs.

Calf V. 3. showed no evidence of infection whatever. Weight 210 lbs.

Calf V. 5. showed a single suspicious elevation on the surface of one lung. Further examination failed to show this to be tuberculosis. No other evidence of tuberculosis was present. Weight 242 lbs.

Test II.

A second infection test was begun for the purpose of determining whether a high degree of resistance was maintained until maturity of the animal.

Animals Used

Calf V. I, Dropped Feb. 83, '05 1st Vaccination April 10, '05	Calf V. 2 Dropped Feb. 28, '05 1st Vaccination April 13, '05

2nd Vaccination July 17, 1905.
and
Control Calf A, Dropped Aug. 25, '05
Control Calf B, Dropped Oct. 12, '05

Temperatures following 1st Injection.

Calf V. 1	9 a. m.	12 n.	5 p. m.
April 11	102.2	.....	.....
April 12	102.0	.....	102.4
April 13	102.0	.....	103.2
Calf V. 2	9 a. m.	12 n.	5 p. m.
April 14	102.4	103.0	103.5
April 15	102.4	102.6	103.2

Temperatures following 2nd Injection.

Calf V. 1	9 a. m.	5 p. m.
July 19	102.6	103.2
July 20	102.4	103.2
July 21	102.6	103.2
July 22	102.8	103.6
Calf V. 2	9 a. m.	5 p. m.
July 19	102.2	103.0
July 20	102.6	102.8
July 21	102.2	102.8
July 22	102.2	102.8

Weights of Animals.

	Vaccinated Calf No. 1 Dropped Feb. 23, 1905		Vaccinated Calf No. 2 Dropped Feb. 28, 1905		Control Calf A Dropped Aug. 25, '05		Control Calf B Dropped Oct. 12, '05	
Age	Weight	Gain	Weight	Gain	Weight	Gain	Weight	Gain
1 mo.	105 lbs.	.....	97 lbs.	.....	82 lbs.	.....	Missing.	.....
2 "	144 "	39	140 "	43	94 "	12	"	.....
3 "	194 "	50	185 "	45	123 "	29	"	.....
4 "	225 "	31	226 "	41	164 "	41	"	.....
5 "	273 "	48	277 "	51	204 "	40	343	....
6 "	299 "	26	315 "	38	255 "	51	391	48
7 "	327 "	28	363 "	48	328 "	73	451	60
8 "	332 "	5	381 "	18	394 "	56	507	56
9 "	369 "	37	409 "	28	420 "	36	558	51
10 "	420 "	51	468 "	59	492 "	72	574	16
11 "	475 "	55	490 "	22	*Killed.	.....	655	81
12 "	552 "	77	552 "	62	....	....	712	57
13 "	615 "	63	617 "	65	....	....	740	28
14 "	653 "	38	680 "	63	....	.....	757	17
15 "	693 "	40	731 "	51	....	.....	820	63
16 "	735 "	42	791 "	60	....	.....	868	48
17 "	781 "	46	827 "	36	....	.....	890	22
18 "	772 "	9	830 "	3	....	.....	....	.....

* Control Calf A had to be killed on account of extensive eversion of the rectum.

Exposure to Infection.

The two vaccinated animals, after having become more than two years old, together with the remaining control were tuberculin tested prior to attempted infection.

Temperature Record April 7th, 1907.

Name or Number of Animal.	Temperatures Before Injection. Hours Before Injection.						Tuberculin Injection.	Temperatures After Injection. Hours After Injection.												Maximum.	Conclusion.
	12	10	8	6	4	2	Am't	2	4	6	8	10	12	14	16	18	20	22	24		
Vaccinated Calf 1	101.4	101.6	101.6	101.8	101.4	....	2 c. c.	....	....	101.8	101.6	102.0	103.0	102.4	102.0	101.6	102.0	101.8	....	.....	....
Vaccinated Calf 2	101.8	102.5	102.2	102.2	102.0	....	2 c. c.	....	....	102.0	102.4	102.6	102.6	102.2	102.2	102.4	101.8	101.8	....	....	....
Control Calf B	102.0	102.0	101.8	102.2	102.0	....	2 c. c.	....	....	101.4	102.0	102.0	102.4	102.2	101.8	102.2	102.4	101.8	....	....	....

These animals were moved April 28, 1907, to an isolated building, and the following week were given 10 cc of a virulent culture of Tubercle Bacilli.

A tuberculin test was made in August, 1907, with no reactions in any case.

In December, 1907, these animals were moved again to a tightly closed building with cement floor.

A tuberculin test was made January 3rd and 4th, 1908, with no reactions.

In the same room (14x14x8) was placed a cow with an advanced case of tuberculosis. These were kept in close contact, with the attempt to restrict ventilation as much as possible.

At the end of ten weeks the cow was destroyed and presented an extreme case of generalized tuberculosis.

Temperature Record.

Name or Number of Animal.	Temperatures Before Injection. Hours Before Injection.						Tuberculin Injection.	Temperatures After Injection. Hours After Injection.												Maximum.	Conclusion.
	12	10	8	6	4	2	Am't	2	4	6	8	10	12	14	16	18	20	22	24		
Vaccinated Calf No. 1	.....	101.6	101.6	101.8	101.6	101.4	2 c. c.	.....	.....	.....	101.8	102.0	102.0	101.8	101.4	101.6	101.0	101.4	101.8	102.0	....
Vaccinated Calf No. 2	.....	101.8	102.0	101.8	101.8	101.6	2 c. c.	.....	.....	.....	101.0	101.0	101.4	101.6	102.0	101.8	101.6	101.6	101.6	102.0	....
Control Calf No. B	.....	101.0	101.2	101.6	101.6	101.4	2 c. c.	.....	.....	.....	101.4	101.2	101.8	101.6	101.6	101.8	101.8	101.6	101.8	101.8	....
Tuberculous Cow.	.....	102.0	102.2	102.0	101.8	102.2	2 c. c.	.....	.....	.....	104.6	105.2	106.4	106.0	105.4	106.4	105.2	105.2	104.6	106.4	....

April 25, 1908, a fresh growth of tubercle culture was obtained from the U. S. Bureau of Animal Industry and an equal amount was given to each in a drench.

July 18, 1908, all three animals reacted as follows:

Temperature Record.

Name or Number of Animal.	Temperatures Before Injection.						Tuberculin Injection.	Temperatures After Injections.												Maximum.	Conclusion.
	Hours Before Injection.							Hours After Injection.													
	12	10	8	6	4	2	Am't	2	4	6	8	10	12	14	16	18	20	22	24		
Vaccinated Calf 1	.....	101.0	101.4	101.6	101.4	101.6	2 c. c.	.....	.....	101.6	102.0	05.0	105.4	104.2	103.6	102.6	....	....	....	...	....
Vaccinated Calf 2	.....	101.2	101.4	101.8	01.8	101.8	2 c. c.	.....	.....	101.6	102.4	103.8	105.6	106.6	106.2	106.0	104.0	....	....	....	....
Control Calf B	.....	100.8	101.2	101.2	101.6	101.6	2 c. c.	.....	.....	101.6	102.6	05.0	105.0	105.2	105.4	105.4	104.8	....	....	....	....

August, 1908, these were slaughtered at the Bennings abattoir and inspected. The following is the report:

Post Mortem Results.

	Calf V. 1	Calf V. 2	Control Calf B.
Inf. Maxillary	Right Gland Tb.		
Retropharyngeal			
Mesenteric	Congested	Congested	Congested
Portal	Congested	Congested	Congested
Liver			
Peritoneum			
Lungs			
Bronchial	Right Gland Tb.		Very large Tb.
Ant. Mediastinal		Tb	
Post Mediastinal	Tb	Tb	
Pleura			

In all 74 animals have been vaccinated and in none of them has there been any evidence of injury or bad effects as a result of the treatment.

Of those which belonged to the Experiment Station Herd three have shown reacting temperatures as shown below:

No. 94 at the age of 3 years and 2 months.
No. 106 at the age of 4 years and 5 months.
No. 115 at the age of 2 years and 9 months.

Temperature Record.

Name or Number of Animal.	Temperatures Before Injection. Hours Before Injection.						Tuberculin Injection.	Temperatures After Injection. Hours After Injection.												Maximum.	Conclusion.
	12	10	8	6	4	2	Am't	2	4	6	8	10	12	14	16	18	20	22	24		
Cow 94	101 6	101 4	101.4	101.0	101.6	.....	2 c. c.	...	......	101.6	101.8	102.6	104.0	104.0	104.0	104.0	103.6	.....	.....	....	....
" 106	102.0	101.0	101.2	101 6	101.6	101 2	2 c. c.	.....	.....	101.8	101.8	102.2	103.0	103.4	104.4	103.4	103.4	.....	.....	....	....
" 115	100.4	100.4	100 9	101 1	101 4	101 4	2 c. c.	.....	.....	101.8	102.2	102.2	102.7	103.4	103.1	104.7	.....	.....	.....	....	....

These three animals were subjected only to the natural exposure existing in a herd that has been more or less infected.

Conclusions.

It is not possible to arrive at correct conclusions regarding the success or failure of a method where the number of tests are so limited. However, these tests demonstrated that young calves vaccinated early in life had sufficient immunity conferred to enable them to resist a degree of infection sufficiently severe as to cause pronounced infection in untreated calves, when this exposure was incurred during the first year of life.

The second test demonstrated that after two years the vaccinated animals failed to offer greater resistance to infection than was possessed by an untreated animal.

The series of vaccinations showed the harmlessness of the treatment as far as the animals themselves are concerned, since no bad results were had in a total of 148 vaccinations or 74 completed immunizations.

Pearson-Gilliland Method.

The credit for first proving the possibility of conferring immunity upon cattle by a systematic inoculation of them with living human tubercle bacilli, and the demonstration of such proof by post mortem findings in treated and untreated animals seems to belong to Pearson and Gilliland. From the first these investigators prepared their vaccine in an emulsified form.

After describing some of their early experimental work the following conclusions were drawn by them.

1. "That after repeated intravenous injections of cultures of tubercle bacilli from human sputum the resistance of young cattle to virulent tubercle bacilli of bovine origin may be increased to such an extent that they are not injured by inoculation with quantities of such cultures that are capable of causing death or extensive infection of cattle not similarly protected."

2. "That intravenous injections of much larger quantities of culture of human sputum tubercle bacilli than are necessary to confer a high degree of resistance, or immunity upon the vaccinated animals, may be administered without danger to that animal."

Heymans Method.

A different method of protecting cattle has been advocated by Heymans of Belgium. The method consists in introducing virulent tubercle bacilli, enclosed in a vegetable fibrous sac, coated with collodion, under the skin of cattle of any age. He claims to be able to confer immunity in this manner, since the bacilli are retained in the sac

and cannot escape, while their products are in direct contact with the circulating blood thereby conferring immunity. There has been practically no experience in this country with his method, and its value is not yet proven.

SUMMARY.

Vaccination with living human tubercle bacilli for the protection of cattle against bovine infection is recognized as successful.

As far as the bovine race is of itself concerned the practice of vaccination is a safe one. TUBERCULOSIS CANNOT BE PRODUCED WITH A NON-VIRULENT VIRUS, THOUGH A VIRUS ATTENUATED ONLY SLIGHTLY BELOW THE POINT OF VIRULENCY FOR THE AVERAGE CALF, MIGHT BE CAPABLE UNDER CERTAIN FAVORABLE CIRCUMSTANCES, OF INDUCING TUBERCULOSIS IN AN UNUSUALLY SUSCEPTIBLE CALF. TO AVOID SUCH A POSSIBILITY, THE VACCINE VIRUSES HAVE BEEN HIGHLY ATTENUATED FOR THE FIRST TREATMENT AND A SUBSEQUENT VACCINATION WITH A LESS HIGHLY ATTENUATED VIRUS, COMPLETES THE IMMUNIZATION PROCESS. THIS CONFERS A DEGREE OF RESISTANCE TO TUBERCULAR INFECTION, WHICH IS A PRONOUNCED FACTOR IN THE WORK OF TUBERCULOSIS ERADICATION.

The investigations of Mohler and Washburn of the U. S. Bureau of Animal Industry have pointed out the extensive modifications which the tubercle bacillus undergoes when propagated under changed environments. They succeeded in interchanging the so-called human and bovine types, both in form and virulence, and apparently established the fact that THE TUBERCLE BACILLUS IS HUMAN OR BOVINE, ONLY AS ITS ENVIRONMENT ESTABLISHES IT.

In view of such interchangeability of form and virulence great caution must be observed in the adoption of methods of vaccination of animals with living organisms, where such animals are destined to furnish food for human use.

It is purely speculative at the present time to assert which is the greater evil,—to permit tuberculosis of animals to continue its existence, without vaccination with attenuated living germs, thus allowing it to become more generally extended, and remain a menace to the human family who depend upon its flesh and milk for food,—or to protect the young animals by this method of immunization, thereby lessening the opportunity for tubercular development in such animals, yet realizing that the germs of human tuberculosis previously attenuated, may be disseminated for a variable time through their excretions.

There is in favor of the practice of vaccination the circumstance that the virus is attenuated and therefore non-infectious and that calves may be treated very early in life, the complete process of vac-

cination ending before they have reached six months of age. The practice of breeding such animals should be restricted so that they would be incapable of furnishing milk at an earlier age than thirty months. This, then, would allow an interval of at least two years in which probably all the organisms would have become eliminated or destroyed.

Under no circumstances, however, should these vaccinated animals be permitted to associate with the part of the herd which is furnishing milk for human use, until they themselves have reached maturity.

Immunization of calves would seem, therefore, to be a justifiable procedure, but should for the present at least, be under the censorship of a proper State Board in order that late vaccination, early breeding and association with cows in milk, be not permitted.

NATURALLY PRODUCED IMMUNITY.

In the paragraph upon susceptibility and predisposition to tubercular infection it was stated that natural susceptibility of individuals and species together with influences favoring the spread of infection, must be reckoned with, in addition to the active causative agent, the tubercle bacillus, in the control of tuberculosis.

It is with the knowledge that the degree of susceptibility of individuals can be modified, and the influences favoring infection can be corrected, that the following departure from the present methods of care and management is urged. Under the heading dissemination and spread of tubercular infection it was pointed out that the principal avenues of infection were by the respiratory passages and the digestive tract.

It is our purpose to show that both the respiratory and digestive functions are to be considered not only from the standpoint of avenues for infection, but equally important as factors in maintaining and influencing the vitality of individuals and their progeny (with respect to natural immunity).

Respiratory Functions.

The physiological act of respiration must be borne in mind when considering tuberculosis from the standpoint of inhalation infection. The components of atmospheric air from the point of view of respiration, are not different since the discovery of newer elements, Argon, etc.; from those long regarded as the essential constituents.

Oxygen, carbon dioxide and nitrogen are therefore the only constituents regarded as important in the light of present knowledge in the respiratory functions. The relative proportions of these substances vary in different localities, but neither these variations, nor the additional constituents found under certain circumstances have ever been demonstrated to effect respiratory processes appreciably.

In general uncontaminated atmospheric air contains: Oxygen 20.96%, carbon dioxide 0.04% and nitrogen 79%. Expired air contains normally about the proportions, oxygen 16.02%, carbon dioxide 4.38% and nitrogen 79%. It will be noted that the volumes inspired and expired are not equal. This is explained by physiologists to be due to the union of the oxygen with hydrogen and carbon eliminated in part as water.

The expired air differs physically from the inspired air in that it is raised to the body temperature and charged with a watery vapor. It has been claimed that in addition to such alterations in air due to respiration, there are toxic or poisonous principles imparted to it. It is safe to say, however, that no such fact has ever been proven, and the effects of re-respired air must be explained in some other manner.

Everyone recognizes the fact that the air of rooms which has been vitiated by breathing becomes foul, that is, it acquires a disagreeable odor, and persons remaining in such a contaminated atmosphere suffer with depression and possibly headache. The odor may be due in part to expired air constituents, but there must be considered also the emanations from the skin in the form of perspiration and sebaceous excretions. Such emanations may account for the odors and possibly for the depressive effects upon the individual breathing such air.

There must be considered in addition to changes of air resulting from respirations the matter of *stale* air of itself.

For purposes of illustration we may compare air with water.

Perfectly pure water, that is, water containing neither soluble nor gaseous substances in solution or suspension, will, in clean vessels, remain pure indefinitely. Ordinary drinking water, however, is usually not found so pure, and confined in vessels becomes flat, foul and possibly dangerous for drinking purposes. Water may be present in streams or reservoirs where its constant movement produces sufficient agitation and aeration to maintain it in a condition favorable for drinking purposes. Water of equal purity, however, may be present in streams or reservoirs where the currents are so sluggish or the volumes so disposed as to minimize currents, and such water will just as certainly become flat, foul and dangerous as though confined in tight receptacles. Such water, though satisfying chemical and bacteriological requirements perhaps, would be unsafe or at least undesirable for continual use, and yet proof of its dangers are wanting. Atmospheric air in nature is in constant motion, and when perfectly pure would, no doubt, remain so, however, confined.

Atmospheric air, however, does become contaminated with gaseous constituents under circumstances of exposure to respiratory and decomposition processes. Unconfined, these added constituents become lost in the currents of our immense volume of atmosphere and cannot be appreciated.

When, however, we shut off a portion of the atmosphere in rooms or enclosures and minimize the natural atmospheric currents

we apply exactly similar conditions as were referred to in contained volumes of water.

Such shut off air in rooms not inhabited becomes flat, foul and it is believed objectionable for purposes of continuous respiration.

After water has served its physiological function in the body it is excreted with positive, well known additions, that are poisonous to the body which eliminated it.

Filtration or vaporization and condensation restores such water to a degree of purity comparable with its original condition and devoid of dangers. When air has fulfilled its physiological functions in the body, it is charged with an increased amount of carbon dioxide and watery vapor and relieved of a portion of its oxygen. The effect of such expired air is known to be detrimental when used over and over again, since the oxygen content becomes less and less and finally fails to supply the body demands, and the carbon dioxide content becomes more and more and finally becomes toxic. In addition to these changes the moisture content and temperature both increase, thereby preventing loss of heat from the body and the production of fever temperatures. While this represents the fatal or extreme termination of continuous respiration of the same air, there is unquestionably a deleterious effect upon a body subjected to a contaminated atmosphere of a slighter degree, and possibly also from the respiration of air no more greatly contaminated than from being *stale*. Is it not, therefore, highly probable that the remote effects upon each successive generation subjected to an atmosphere only partially contaminated will be shown in a lowered vitality?

The influence of variations in composition of the air breathed have been studied by careful observers. The results of such observations briefly are:

1. The variation of the amount of nitrogen has no apparent physiological effect.

2. Inasmuch as oxygen in normal atmospheric air is in excess of the needs of the body, and the depletion of such air by the oxygen necessary for respiration is comparatively slight, unless long continued in a tight compartment, the oxygen content of itself does not exert any marked influence upon respiratory movements. A depletion to approximately 50 per cent. of the oxygen of normal air is necessary before respirations are affected.

3. An increased per cent. of carbon dioxide has been shown to augment respiratory movements up to a concentration of about 15 per cent. after which the respirations are decreased to the point of fatal narcosis at from 40 to 50 per cent. concentration.

The presence of a certain amount of carbon dioxide in the surrounding atmosphere limits distinctly the amount thrown off from the lungs, AND IN ORDER TO HAVE THE FULLEST ELIMINATION OF CARBON DIOXIDE FROM THE LUNGS THE SURROUNDING AIR MUST BE VIRTUALLY FREE OF THIS GAS.

Thus we see that it is not that insufficient oxygen is present in rooms to support the body or the intake of carbon dioxide from a contaminated air that is harmful, but the fact that carbon dioxide cannot be properly eliminated into an atmosphere already laden with this gas. Smith states that the presence of 5% carbon dioxide remaining in the air breathed will produce fatal results, and 2½% soon produces depressing influences.

Suggestions have been made that certain cosmic influences may affect body metabolism and thus influence respirations, and the fact remains that experimental evidence is wanting which explains the relationship of the composition of air with the respiratory acts.

Since an increased per cent. of carbon dioxide accelerates respiratory movements up to a concentration of about 15%, it is evident that where this air is contaminated with tubercle germs the possibilities of inhalation infection is increased rather than diminished. A closed stable poorly ventilated has at the same time a heated atmosphere which tends to make the respirations shorter and quicker.

Short, quick respirations involve principally the larger lung spaces and do not produce a full expansion in the terminal air cells. On the other hand, animals breathe deeper but more slowly in the open air than in stables. When first passing into the outer air from a closed building all animals take an unusually deep breath. This deep breathing, though not so pronounced as at first, continues during the time that they remain in the outside air and becomes restricted upon returning to the interior of closed buildings. The warmer and fouler the air the more rapid, but LESS EXPANSIVE are the chest movements, and conversely the more expansive do these movements become, with the purity and coolness of the air, within, of course, proper limits in each instance.

The degree of expansion to which the chest is subjected, directly influences the fullness of the terminal air cells and consequently the *movement* of the lungs.

The presence of carbon dioxide, due to its imperfect removal in the expiratory act, results in a *diminished blood supply*, and a more complete removal of carbon dioxide establishes a fuller circulation in the lungs. We find, therefore, that an animal in the protected stable makes a more shallow respiration, accompanied by only slight lung movements and has a slight blood supply in the air cells.

Such a condition of *diminished oxygen supply,* approximate *rest of the tissues* and *slight blood supply* at the terminal air cells is favorable for the lodgment and propagation of the tubercle bacillus. Such a condition exists in cattle as at present housed and such condition demands correction.

The domestication of cattle has in many ways tended to decrease the necessity for chest expansion. Exercise and the influence of fresh air and changing temperatures have been minimized by our present system of stabling cattle.

The improvement in the capacity for production in cattle has been accomplished through selective breeding, with the production object principally in view, and chest development secondarily considered. This practice has unquestionably developed a more delicate type of cattle, and chest capacity is lessened as well.

The aim in breeding, therefore, must be directed towards the correction of this fault. The system of stabling here advocated, with the added features of exercise, fresh air and changing temperatures, will tend to overcome this evil.

It was with a full realization of the benefits obtained in the treatment of human tuberculous patients, that we planned several years ago the type of stable in use at this place.

The actual plan of our stable is of course not material, as long as the principles and practices are similarly carried out; however, reference is made to this structure because it has been in operation long enough to demonstrate its practicability.

M. A. E. S. OPEN STABLE.

The stable is of solid concrete construction, with slate roof. The stabling portion is 36x58 feet, and the milking room annex 10x30 feet outside measurements.

The walls of the milking room are 12 inches thick of solid concrete, and 9 feet high. Into this room two doors enter from the stable, and one from the outside. It contains four windows 3x3½ feet hinged at the bottom which open inward at the top to 9 inches, and are protected along the sides by galvanized iron cheeks to prevent direct air currents upon the cows and milkers. There are also two 6x18 inch flues in the walls for purposes of ventilation. The floors are of concrete. and slope towards the traps for proper drainage.

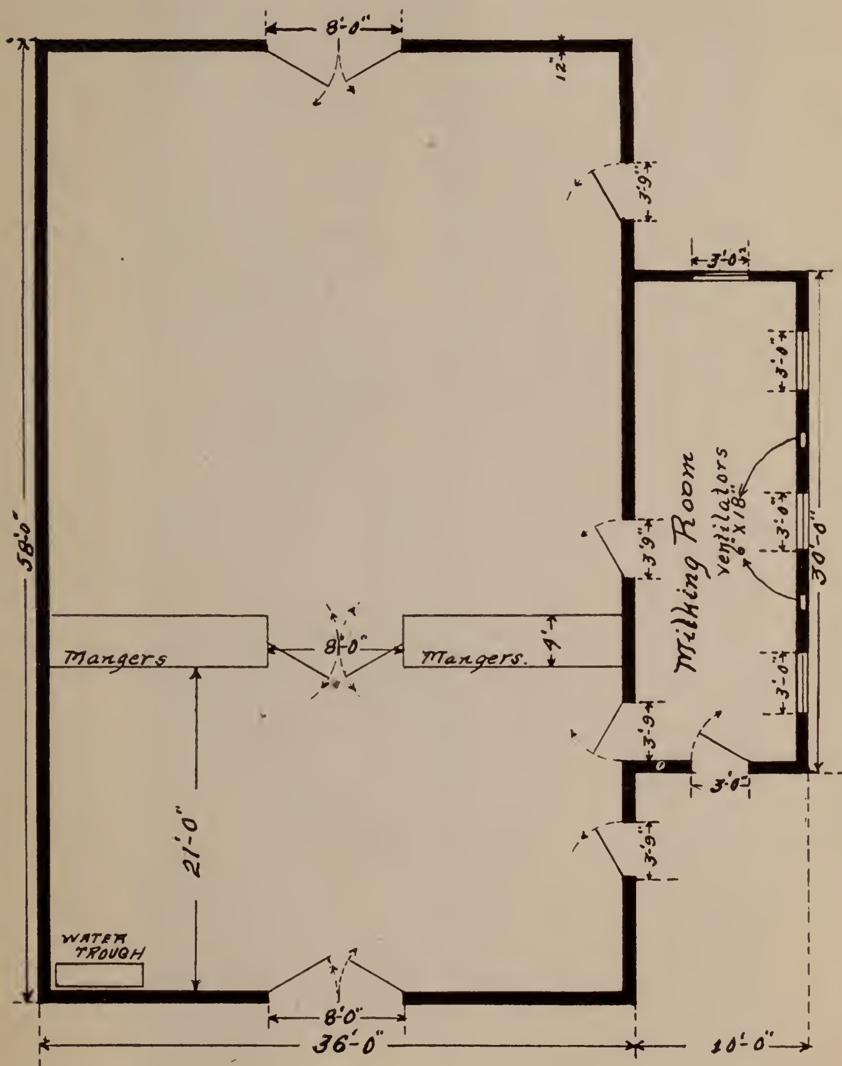
The walls of the stabling portion of the building are of 12 inch solid concrete, but only 4½ feet in height. There are two 8 feet openings in the ends, protected by solid gates, and two four feet openings on one side, protected likewise by solid gates. The floor is of concrete and practically level, a slope to the drain being provided should it be found necessary to wash off the floors.

On the top of the outside wall are set 8x8 oak posts properly placed for the support of the plates carrying the roof; and near the corners anchor irons, with turnbuckles, are let into the concrete wall and plates for properly securing the superstructure. The ordinary roof construction is used for closing in the top.

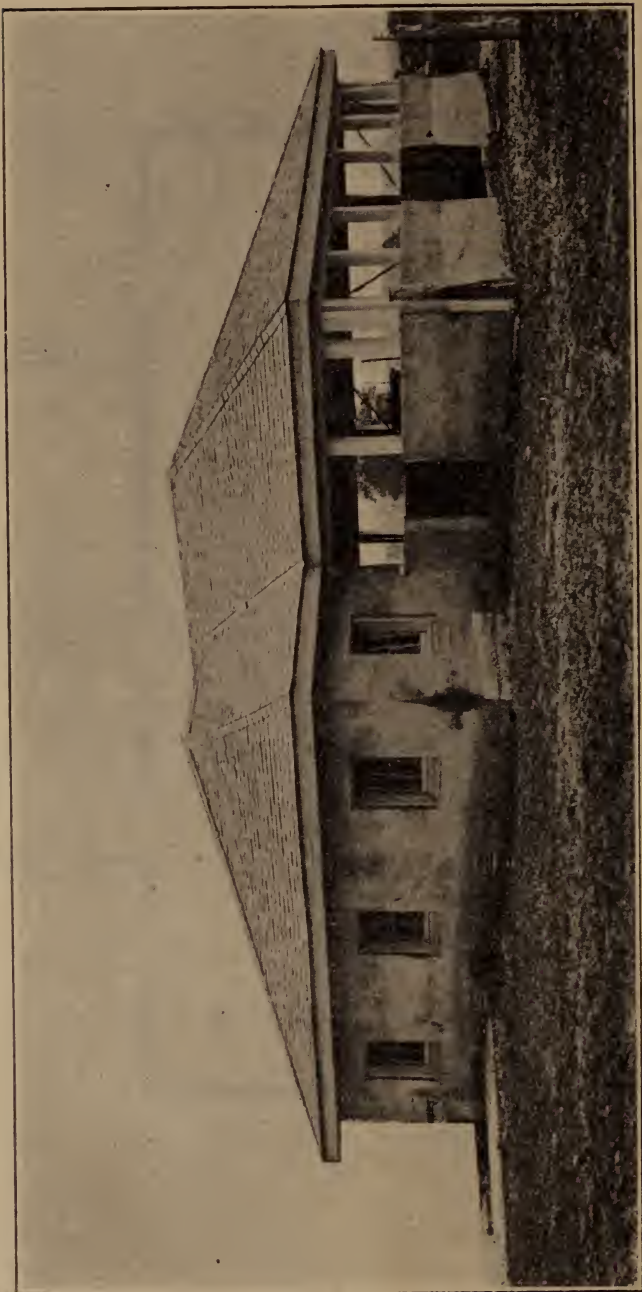
This it will be observed allows an open space 3 feet 6 inches high around the entire building, with the exception of that occupied by the milking room. There are no blinds, sashes nor curtains to interfere with the free circulation of air and perfect light is had in all parts.

There is a double row of racks built across the stable which divides the room into two compartments 23x34 feet and 33x34 feet respectively. In the 23x34 feet end is a watering trough and hydrant.

The illustrations show more clearly the salient features of the stable than a description can possible do.



FLOOR PLAN OF MARYLAND AGRICULTURAL EXPERIMENT STATION OPEN STABLE.



OPEN DAIRY STABLE.
Maryland Agricultural Experiment Station.

The capacity of this stable is about twenty-five head of milch cows. The management of these differs from that of cows in closed stables.

The cows are not tied, and are free to move about in the entire enclosure. The racks are kept supplied with the coarse feed, ensilage, roots, etc., to be consumed at their pleasure. Drinking water, too, is accessible at all times.

When ready for milking, all the cows are driven into the smaller compartment and the gates closed. The door to the milking room is opened and sufficient cows are allowed to pass in to fill the stalls. These eat their grain and are milked. They are then let into the larger compartment, and others enter. This is continued until all are milked, when the centre gates are opened and the free run of the stable is given until the next milking time.

It is anticipated that objections will be raised to the practice of feeding grain at milking time, but as before stated it is not material that the exact plan and method of feeding be followed so long as the following points be observed, and these are regarded as vital.

1. Air, light and changing temperatures must be supplied as freely and unrestricted as outside conditions will furnish.
2. Food should be plentifully supplied and accessible at all times.
3. Water should be always available.
4. Cows should not be tied except in the milking room.

The reasons for the first requirement have been previously stated.

Accessibility to food and water, constantly, smacks of Fletcherism but it is recommended because it is a natural condition, and cows do well as a result. Pasturage does not produce the largest milk returns solely because of the palatability, succulency and character of the food afforded. It is because food and water being constantly available are naturally consumed and digested under conditions of freedom and abundance of air and light. Probably the greatest criticism against such a practice will be directed at the suggestion for exposure to extreme winter temperatures. The popular notion that "to get milk you must have warm stables" is as fallacious actually, as it has proven pernicious practically.

In order to show the results of a severe winter's exposure the following table is presented.

TABLE I.

	1908 October	1908. Nov	1908 Dec.	1909 Jan.	1909 Feb.	1909 March	
	Lbs. milk	Lbs. milk	Lbs. milk	Lbs. milk	Lbs. milk	Lbs. milk	
143	674^{3} ⊕	614^{4}	566^{5}	476^{6}	359^{7}	269^{8}	NOTE—These cows were kept in the open stable but averaged 3½ hours daily in closed stable when they were milked.
144	665^{4}	684^{5}	719^{6}	669^{7}	569^{8}	623^{9}	
145	687^{3}	632^{4}	567^{5}	509^{6}	370^{7}	341^{8}	
146	....	....	....	593^{1}	581^{2}	609^{3}	

	1909 October	1909 Nov.	1909 Dec.	1910 Jan.	1910 Feb.	1910 March	
Max. Temp.	....	76° F	62° F	51° F	60° F	....	
Min. Temp.	....	24° F	5° F	7° F	5° F	....	
143	197^{1} ⊕	989^{2}	980^{3}	928^{4}	825^{5}	844^{6}	NOTE—The same cows as above, but were kept in the open stable, and milked in the milking room of same.
144	251^{16}	142^{17}	209^{1}	903^{2}	950^{3}	783^{4}	
145	917^{1}	1041^{2}	1001^{3}	883^{4}	755^{5}	796^{6}	
146	57^{10} 84^{1}	865^{2}	742^{3}	600^{4}	491^{5}	479^{6}	

	1908 October	1908 Nov.	1908 Dec.	1909 Jan.	1909 Feb.	1909 March	
91	542^{3} ⊕	520^{4}	586^{5}	639^{6}	553^{7}	600^{8}	NOTE—Kept in closed stable.
106	....	....	282^{1}	562^{2}	516^{3}	556^{4}	
110	....	86^{1}	385^{2}	472^{3}	488^{4}	553^{5}	
113	....	25^{1}	490^{2}	476^{3}	454^{4}	500^{5}	
123	1174^{2}	1177^{3}	1240^{4}	1169^{5}	1021^{6}	1043^{7}	

⊕ Small figures refer to month of milking period.

TABLE I—Continued.

	1909 October	1909 Nov.	1909 Dec.	1910 Jan.	1910 Feb.	1910 March	
Max. Temp.	....	76° F	66° F	60° F	72° F	....	
Min. Temp.	....	48° F	32° F	37° F	34° F	....	
91	543[3] ⊕	510[4]	489[5]	369[6]	....	....	NOTE—Kept in closed stable.
106	317[11]	291[12] 261[1]	585[2]	459[3]	446[4]	469[5]	
110	349[12]	250[13]	177[14]	58[15]	252[1]	839[2]	
113	472[1]	783[2]	729[3]	657[4]	555[5]	605[6]	
123	616[14]	101[15] 487[1]	1203[2]	1016[3]	... .	....	

⊕ Small figures refer to month of milking period.

Attention is called to the fact that cows 143, 144, 145 and 146 were kept in the open stable during the winter of 1908-9, but were milked in the closed stable. By this arrangement the cows spent the night in the open stable and were brought into the warm closed stable early in the morning to be grained and milked. They averaged about 2½ hours in the warm stable in the morning after which they were again placed in the open stable. In the afternoon they averaged about 1½ hours in the closed stable, before returning to the open stable for the night. This unnatural and sudden change of temperature, probably had some effect in keeping their milking record lower for the winter than they would have shown, had they been confined in either one or the other of the stables regularly.

To a less extent this abrupt temperature change occurs in the closed stable practices in general use. The records for the winter months of 1909-10 show a decided increase in yield, and OUR POSITION MUST HERE BE EMPHASIZED THAT WE ARE NOT AT THIS TIME CLAIMING ANY INCREASED PRODUCTION BY THIS PRACTICE, BUT DO CLAIM THAT A REDUCTION IN PRODUCTION IS NOT NECESSARILY BROUGHT ABOUT BY EXPOSURE TO LOW TEMPERATURE, WHEN THESE EXPOSURES ARE NATURAL AND CONSTANT.

The discussion as to the merits of the open stable as affecting milk production are only incidental, and will be reported upon more exhaustively at a later period.

Having explained the plan for the open stable in its relation to cows in milk, it is only necessary to refer to the principles involved, when considering the management of a herd from the point of view

of lessened susceptibility to tuberculosis, which will be done while discussing the Digestive System and Feeding as relating to tuberculosis and strengthened vitality.

Digestive Functions.

Under Food and Drink (P. 279) it was stated that the digestive tract offered opportunities for infection which greatly overshadowed all others and conditions were such that they were not so easy to control.

Cattle in nature secure their food in a more or less succulent condition, at irregular but frequent intervals and digest it leisurely. They need only to support their bodies and supply milk in limited quantities for their offspring until weaned. The quantity of milk made is small and the period of lactation is short. When, however, cattle are domesticated these conditions are vastly changed.

The character and quantity of food and the time and manner of eating it are altered.

Her whole being is transformed from a natural state to an unnatural state, and artificial practices must be resorted to. It is a fact, however, that these practices have been more widely at variance with nature than necessities justified, and lowered vitality has in a large measure resulted.

A system of feeding has been followed without due consideration of the fact that it requires energy to digest food. A system of feeding for milk, in the lactating cows, is found to produce excellent results, it is without reasoning applied to the heifer and again to the calf. The result is a breed of delicate living milking machines, without a high degree of stamina.

We are compelled, however, through circumstances to adhere to many artificial procedures in the care and management of animals under domestication and it is therefore highly important to stick to nature as closely as possible where it can be done.

The natural food for the calf is milk, and were it not for the fact that we are guarding in every possible way against tuberculosis infection, would be recommended under all circumstances as the first food. The writer is firmly of the opinion that considerable infection of cattle occurs in the very young animals, not necessarily because milk becomes infected in the udder, but because of its liability to infection before it is fed. It is desirable to "make the milk safe" for calves or use "milk substitutes" prepared from cereals and similar products.

The calf and later the heifer is fed as nearly as possible such mixtures of coarse forage and grain as would approximate their natural food, and neither allowed to rough it on coarse forage alone until ready to drop her calf nor forced with a mixture appropriate for a cow in milk. In short, without entering into a discussion of rations she should be "grown up" upon a balanced ration with plenty of bulk,

and as much succulence as circumstances will allow, until she reaches maturity and brings forth her first calf. This period of her life should be spent in an open stable with access to pasture or paddock and entirely apart from the cows in milk.

When she has calved and is ready for her work of milk production her feed should be modified to the point of properly lessening the bulk, maintaining succulence and supplying the principal nutrients in concentrated form even to apparently excessive amounts. The purpose being to divert the energy from digestion to milk production.

When a cow is dried off from milk production she should return to her diet of bulky food and reduced concentrates. She should also be provided with stabling quarters separate from the cows in milk and separate from the younger calves. In fact, there should be quarters for cows actually in milk, quarters for dry cows and bred heifers, and quarters for young heifers and calves. Inasmuch as open stables can be constructed at very much less cost than the ordinary type of closed stables, the suggestion made for separate quarters does not entail such extravagant expenditures as appears necessary at first glance. It must be constantly borne in mind that the primary object is to SUPPRESS TUBERCULOSIS AND KEEP IT SUPPRESSED.

BY THIS PLAN THE DANGERS OF TRANSMISSION FROM ANIMAL TO ANIMAL ARE SUBSTANTIALLY ELIMINATED; SINCE ANIMALS BREAK DOWN, WHEN INFECTED, UNDER PRESSURE OF CONFINEMENT AND FORCED PRODUCTION, THROUGH FEEDING, PRINCIPALLY.

CONTROL OF TUBERCULOSIS.

It is must be reiterated that the control of tuberculosis cannot be successfully had unless there is a general, active, unselfish interest displayed in the work by the general public. Of necessity, however, the great burden of work falls upon the owner of animals while the public acts principally through the several State departments.

It is desirable, therefore, to briefly review the duties of the owner of animals and of the State in contributing to the suppression of this disease.

Individual Suppressive Measures.

For some unexplainable reason the general policy of suppressing tuberculosis has been to work backwards. That is to say, the disease has been sought for in herds and tuberculous individuals removed. Later this search is renewed when more diseased animals are found and disposed of. This practice continues until in many instances the interested, rightly disposed owner, becomes disgusted with his failures and disposes of his stock or allows the disease to run its own course under the impression that it cannot be checked.

The recommendations here offered are known to be founded upon right principles.

1. Provision must be made for as many calves and heifers up to two years of age as it is intended to raise. A yard, paddock or pasture lot which must not be used by the older cattle, and preferably not by hogs, should be provided containing a shed structure which offers the light, air and temperature conditions referred to in the open stable. DO NOT CONFINE ANY OTHER CATTLE IN THIS PLACE EXCEPT THOSE GROWN THERE FROM CALVES.

2. A similar provision must be made for dry cows, the heifers which are bred, and possibly also for the bull.

3. With these animals provided for, there remains only the cows actually engaged in the production of milk. Unless it is possible to provide an open stable with a milking room, there can be much done towards securing similar results with the stables already in existence. In general it can be said that every unnecessary partition and obstruction should be removed and light and air admitted freely. Where possible provide sufficient stalls for cows in milk and partition off and throw open the remainder of the stable for the cows to remain in when not actually stalled for milking purposes. Such provision for the herd approximates natural conditions as far as stabling is concerned.

MANAGEMENT.

Calves.

Begin with the newly born calf to develop the healthy cow, and feed from the beginning, pasteurized milk or calf meals. (Pasteurizing can be done by heating milk for 20 minutes to 150 degrees Fahrenheit). DO NOT FEED THEM WITH RAW MILK FROM ANY COW, NOT POSITIVELY KNOWN TO BE FREE OF TUBERCULOSIS. (In case of diarrhoea or scours in calves decrease the food and add to it one teaspoonful of a mixture of one ounce of Formaldehyde in one pint of water).

After weaning and until bred keep these young animals continuously supplied with water and properly balanced but bulky food. DO NOT USE THE YARDS IN WHICH THESE ANIMALS ARE CONFINED AS A DUMPING PLACE FOR MANURE OR LITTER FROM THE COW STABLE OR HOG PENS.

Heifers.

For the best results heifers should be bred to calve at not earlier than 30 months old. After the heifers are bred they should be kept in the second inclosure and shed until they calve. In this inclosure also may be kept the bred dry cows and bull, provided they have been proven free of tuberculosis by the tuberculin test. Similarly these

animals must be continuously supplied with water and a properly balanced bulky food.

In this inclosure too, there must be nothing deposited from the cow stable or hog pens which might transmit infection.

After freshening, the calf is removed to the first inclosure and the cow to the third inclosure, reserved for cows in milk.

Cows.

In the cow stable then, we find only cows producing milk. If practicable these should be tuberculin tested and reactors promptly and properly disposed of.

If this be not practicable this herd can be tested and a further separation made after the manner of Bang's system already referred to.

With these animals only should there be any tendency towards concentrated and heavy feeding. Recently fresh cows should be judiciously brought over from bulky coarse food to more highly concentrated food, bearing in mind that you desire the direction of energies towards milk production rather than food digestion.

It is the writer's opinion that proper grain rations can be successfully and economically fed to an amount approaching 50% increase over the ordinary methods of feeding.

The fact must be borne in mind, however, that such a practice is a safe one only when the conditions under which the animals have been reared and maintained conforms to those recommended.

As cows become dry they must be proven healthy by the tuberculin test before entering inclosure No. 2.

Similarly all new additions to a herd must be proven healthy before mingling with the animals in any of the inclosures. Such a system will surely develop a healthy and more highly resistant herd of cows, and will do so at no greatly increased cost.

When examined carefully it will be noticed that two sets of fences and two open sheds only, are needed in addition to the stable which is already in existence or necessary to be provided at any rate.

The labor of caring for the several groups of animals is greater, but not so much so as to be prohibitive. The results, when the details are conscientiously carried out, are sure to be successful and therefore the extra expense is justified.

State Suppressive Measures.

IF THE PUBLIC FULLY REALIZED THE IMPORTANCE OF TUBERCULOSIS SUPPRESSION IN ANIMALS THERE WOULD BE NO TIME LOST BY THE STATE IN SYSTEMATICALLY AIDING THE BREEDER IN THE CONTROL OF THIS DISEASE.

The failure of some States in the endeavor to suppress the dis-

ease is no argument that the task is an impossible one. There are a few axiomatic facts that are well to be borne in mind.

Tuberculosis cannot be legislated out of existence.

Liberal indemnities will encourage the existence of the disease.

Tuberculosis of cattle is a public calamity and not a private misfortune.

A diseased "scrub" and a diseased "pure breed" may be equally capable of spreading tuberculosis.

The public pays the losses due to tuberculosis and the public (the State) can well afford to pay for proper measures of suppression.

With the assumption that the public is alive to the necessity for correcting the evils of animal tuberculosis, and the further assumption that they will be patient in the realization of results, the following scheme is submitted for the consideration of the people of Maryland with the hope that it or some superior plan be entered upon for the relief of the situation as it now affects our cattle and hogs, not disregarding the relation to human tuberculosis.

ORGANIZATION.

There should be created an Animal Tuberculosis Board, appointed by the State Board of Agriculture. This board should be composed of three men known to be conscientiously and fully in sympathy with the importance of the work. One of these men should be a veterinarian, with long experience in country practice, another should be a human physician, preferably one who has made a specialty of dietetics, and the third a practical breeder of cattle or dairyman with some years of experience. This board should be given proper authority by the legislature to make regulations having the effect of laws, similar to that conferred upon the State Board of Health and the State Live Stock Sanitary Board.

Under the Animal Tuberculosis Board and directly responsible to them should be a chief and five deputy veterinarians.

The deputy veterinarians should be assigned to well defined districts into which the State would be divided, and would be held responsible for the work in such districts.

Assigned to each deputy veterinarian should be a corps of official inspectors for the actual work of tuberculosis suppression.

With respect to the veterinarians, personal and professional qualifications must of course be considered. The inspectors however must be trained by special courses of instruction to qualify them for their duties and should be held up to a rigorous examination before the State Veterinary Examining Board and their competence certified to by them before eligible for appointment. Such a procedure is necessary as properly qualified men are not available for the duties which will be exacted of these inspectors. The course of instruction should thoroughly equip the men in all details of the services which they would be expected to perform. By the above arrangement the same board

would pass upon the qualifications of these inspectors as judge the qualifications of candidates for admission to veterinary practice in the State. These then would constitute the organization force for the work of the Animal Tuberculosis Board.

WORK.

The work of tuberculosis suppression is of necessity one of a cooperative character. As the individual alone can do only a part of the work of suppression, so it is with the State, and mutuality of interest therefore must be the principle upon which the work is planned. That is to say, the animal and dairy interests as a whole must be regarded along with that of disease suppression.

The owner must be aided in the work and not driven, he must be protected and not ruined. He must be shown how to economically readjust the management of his herd in order to breed up a healthy herd from his diseased herd. HE MUST BE SHOWN HOW TO "MAKE HIS MILK SAFE" FOR HUMAN FOOD AND THEN BE PERMITTED LEGALLY TO DISPOSE OF IT.

HE MUST BE PROTECTED BY THE STATE AGAINST THE POSSIBILITY OF BRINGING INTO HIS HERD A DISEASED ANIMAL, AND INDEMNIFIED FOR ANY DISEASED ANIMAL WHICH HAS BEEN CERTIFIED TO BY A STATE OFFICIAL AS HEALTHY. HE MUST BE ASSISTED BY THE STATE IN DISPOSING OF ANY TUBERCULOUS ANIMAL.

Where stabling conditions and proper management justifies it, the State should immunize the calves and tuberculin test the herd at proper intervals.

When healthy herds are encountered or established they should be properly safeguarded and maintained so.

There is, however, the fundamental principle of cooperation to be considered and this does not mean that the State does all the work or even aids in the work, unless a proper spirit and willingness to help is displayed by the owner.

The labors of such an organization as has been described cannot be expected to end short of a period of years and certainly assurances that the work will be continued, when begun, are vital.

In the beginning, probably the safest plan would develop from actual agreements between the stockmen and the State as to what would be required of each in the work at hand. As the work progressed the good effects would be enjoyed and the moral effect on surrounding communities would be beneficial.

Quarantine authority would have to be employed under some circumstances, no doubt, but the greatest good would come from an endeavor by the State to assist the owner in stamping out the trouble rather than forcing him to do so.

Actual plans and procedures for a campaign of this kind must nec-

essarily be formulated by the Board having jurisdiction, and such discussion has no place in a report of this character.

In conclusion, however, it is important to emphasize the fact THAT TUBERCULOSIS IN ANIMALS IS NOT AT A STANDSTILL, AND UNLESS IT IS BRED OUT, VACCINATED AGAINST, AND FOUGHT ALL ALONG THE LINE WITH A FORCE LARGE ENOUGH TO SUPPRESS IT THERE WILL BE AN EXTENSION OF THE DISEASE. With properly organized forces working from a central head having all records, transfers, and tests at hand, the work will positively succeed and it needs only the sympathetic interest of the people and wise and liberal legislation and appropriations by the General Assembly.

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